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**Zoological Studies**  
(Fifth Series)

# University of Aberdeen.

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# Zoological Studies

chiefly on

## Alcyonarians

(Fifth Series)

By

J. Arthur Thomson, M.A.

*Professor of Natural History*

J. J. Simpson, M.A., B.Sc.

*Carnegie Fellow*

R. N. Rudmose Brown, D.Sc.

Sophia L. M. Summers, M.A., B.Sc.

George Crane, B.Sc.

James Ritchie, M.A., B.Sc.

ABERDEEN

Printed for the University

1911



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# V.—Note on a Hydrocoralline from Rockall.

By Professor J. Arthur Thomson, M.A.

(Read 20th December 1909. Received 20th December 1909.)

I RECEIVED this summer, from a trawler, three pieces of an interesting Hydrocoralline brought up near Rockall,—that lonely granite rock in the North Atlantic ( $57^{\circ} 36' N. lat.; 13^{\circ} 41' W. long.$ ),—184 miles west of St Kilda, 260 from the North of Ireland, 290 from the nearest part of the mainland of Scotland. As northern records of Hydrocorallinæ are few and far between, it is of interest to register this one.

The specimens are white flabellate colonies which agree with the description and figures of *Stylaster gemmascens* (Esper) given by Professor P. Martin Duncan (*Trans. Zool. Soc.*, viii., 1874, p. 332, pl. ix. 12 figs.). The diagnosis, quoted by Duncan from Milne-Edwards and Haime, reads :—"The corallum is subflabelli-form. The branches often coalesce, and the younger are crowded with small granulations, which are irregularly placed between the calyces. The old branches are almost smooth. The calyces are alternate on young branches, and sparingly developed on the old; they are circular, oval, or deformed, and have projecting margins. There are from twelve to sixteen septa, which are often irregular."

The surface of the colony shows the "cups" that are characteristic of Stylasterids. They occur all round the smaller branches, but are chiefly lateral on the larger. Each "cup" consists, as is well known, of the cavity of a nutritive polyp or gastrozoid, surrounded by a circle of twelve or so smaller cavities lodging the tactile dactylozooids. Each cup bears a deceptive resemblance to the calyx of a Madrepora, a resemblance heightened in some cases, notably in *Aulopora*, by septa-like ridges extending inwards from the dactylozooids. It is historically interesting to notice that in Martin Duncan's memoir of 1874, where this form is beautifully figured, it is still misinterpreted as a Madreporarian, with which it has, of course, nothing whatever to do. To get a general picture of the nature of a Hydrocoralline colony, we have to imagine a much-branched hydrorhiza in which lime is secreted from the tubes instead of a perisarc, so that numerous fine canals are enclosed in a coherent calcareous framework. To this we have to add that the polyps are dimorphic or trimorphic,—gastrozooids, dactylozooids, and sometimes medusoid reproductive buds.

The type of *Stylaster gemmascens* came from the Indian Ocean. The North Atlantic forms identified with the type were dredged by the "Lightning" and the "Porcupine" (530 fathoms). Another record is given by Sars (*Forh. Selskabs Christiania*, 1872, p. 115), from a great depth in the Foldenford, Norway.

(Issued separately, 18th February 1910.)

"



VI.—On a new Pseudaxonid Genus—*Dendrogorgia*. By Jas. J. Simpson, M.A., B.Sc., Carnegie Research Fellow, University of Aberdeen.

(Read 20th December 1909. Received 20th December 1909.)

IN 1900 Professor Hickson (*Marine Investigations in South Africa—The Alcyonaria and Hydrocorallinae*, p. 85) described two specimens under the name of *Juncella elongata* (Pallas), with the following observations:—

“Owing to the very imperfect state of our knowledge of the *Juncella* group of Alcyonarians, I have considerable hesitation in naming the two specimens of the genus sent to me from the Cape. . . . One of the most characteristic features of the specimen is the great preponderance of triple-star spicules 0·07 mm. in length, but there are also many spicules of the shapes known as double-stars, warted spindles, etc. There are very few spicules of the club-shape which are so characteristic of the species *J. juncea* and *J. gemmacea*.”

The specimens were dredged at Rij Bank, off Algoa Bay, long. 25° 51' 30" E., lat. 33° 58" S. Depth—25 fathoms. Bottom—dark sand.

In 1904 (*Alcyonaria of the Cape of Good Hope*, part ii., p. 233), while admitting that the triple-stars might be regarded as a character sufficient to distinguish these specimens as a distinct species, Professor Hickson refrained from doing so, but renamed them *Juncella elongata* (Pall.) var. *capensis*.

Professor Hickson very kindly sent me a small portion of one of his specimens along with various Juncellids, and later, Professor Thomson placed a magnificent specimen, identical with the type, at my disposal. The latter specimen was also found at the Cape.

Owing to the inadequate descriptions of *Juncella elongata* very diverse forms have been, from time to time, ascribed to it, but an investigation of the spicules hitherto undescribed, has shown that the specimens under consideration—Professor Hickson's and ours—cannot be referred to the genus *Juncella*. In fact the specimens do not belong to the Juncellids at all.

Before entering into a discussion of the systematic position of our specimen, we shall give a short description supplementary to that which Professor Hickson gave of those specimens which he referred to *Juncella elongata* (Pallas) var. *capensis*, n.

*Dendrogorgia capensis*, n. gen. et sp.

A beautiful specimen of a deep-red colour (Fig. 1), massive in appearance, and branched openly in one plane in what is evidently a false dictotomy.

The base is wanting. The total height of the colony is 20 cm. and the maximum breadth is 3.5 cm. The diameter of the main stem at the base is 9 mm. Near the base it gives rise to two primary branches with diameters of 8 mm. and 7 mm. respectively. The former divides after a distance of 10.5 cm., giving rise to a branch 6 mm. in diameter at its point of origin. The latter branches after a distance of 5 cm.; the diameter of this secondary branch is 6 mm. Slightly beyond this point the main branch has been contorted and curves towards the secondary branch.

All the branches taper very slightly; one, however, maintains its original diameter throughout and terminates bluntly in a dome.

The axis is 5.5 mm. in diameter at the base and tapers to a fine point in the branches; it is comparatively soft and is easily cut with a knife. The horny part is spongy and the calcareous portion is composed of long smooth or slightly warty irregular spicules, quite unlike those of the *cœnenchyma*. These are longitudinally disposed. The axis is composed of concentric layers, which, however, are not very distinct; the outermost of these may be detached in flakes, and the actual arrangement of the spicules is there visible. When boiling down the *cœnenchyma* in strong caustic potash many of the spicules become detached from the axis, and prolonged boiling of the axis disintegrates the greater part of it. The axis is separated from the *cœnenchyma*-proper by a thin horny layer in which spicules identical with those of the axis are embedded; this detaches with the *cœnenchyma*, but it is undoubtedly a young layer of the axis.

The *cœnenchyma* is almost uniformly thick throughout, being, however, slightly thinner towards the base. The proportion of *cœnenchyma* to axis is markedly different at the various levels (Fig. 3), but in this connection it is noteworthy that increase in thickness towards the base is due not so much to growth in the *cœnenchyma* as to growth in the axis. The *cœnenchyma* is comparatively soft, but at the same time densely spiculose.

*Canal system* (Fig. 2).—Around the periphery of the axis there is a series of minute longitudinal canals all of the same size. Towards the outside of the *cœnenchyma*, between the polyps, not internal to them, there are also a number of longitudinal canals, and several are also scattered in the *cœnenchyma* between these two series. The whole of the *cœnenchyma* external to the inner series is penetrated by a net-work of transverse canals uniting the various longitudinals.

The polyps are distributed over the whole of the *cœnenchyma* (Fig. 3), the actual number at one level being dependent upon the position in the colony. There are no very distinct verrucæ, due no doubt to the great thickness of the *cœnenchyma*; the anthocodiæ are withdrawn into the

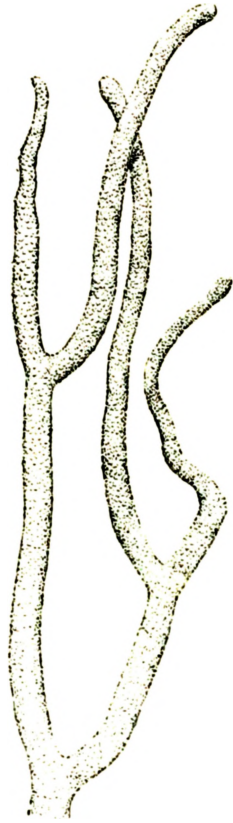


FIG. 1.  
Colony, to show general habit.

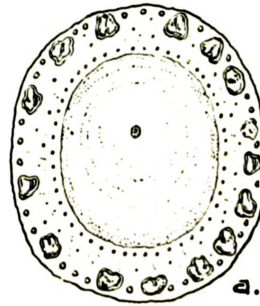
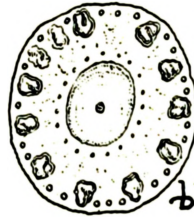
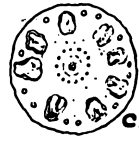


FIG. 2.  
Transverse sections at three levels, to show the  
internal structure.



FIG. 3.

Small portion enlarged, to show the nature and distribution of the verrucae.

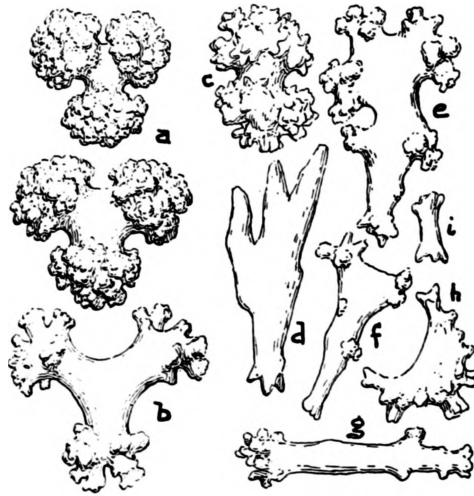


FIG. 4.

Spicules.

cœnenchyma, and their position is marked by a slightly elevated wart-like projection with a central pore, around which may be discerned an eight-rayed figure.

The spicules of the cœnenchyma (Fig. 4, *a*, *b*, and *c*) consist almost entirely of triple-stars. Of these there are two distinct types—(*a*) triple-stars with very densely-warted and closely-set heads, and with very short handles; (*b*) triple-stars with much longer handles and with the heads covered with openly-set long warts; (*c*) a few double clubs also occur. Most of these spicules are red in colour. The spicules of the axis are colourless; they are very irregular in shape. Some are almost smooth, while others are warty. A few of the characteristic variations in these spicules are shown in Fig. 4 (*d-i*).

The following are some of the measurements<sup>1</sup> in millimetres:—

1. Cœnenchyma (Fig. 4, *a-c*).

(*a*) Triple-stars with short shafts and densely-warted star portions.

0.076; 0.068; 0.065; 0.038; 0.03.

(*b*) Triple-stars with long shafts and with few simple warts in the star portion.

0.087; 0.068; 0.065; 0.053.

(*c*) Double-stars—a few of these occur, but they are usually small and may be undifferentiated triple-stars.

0.072 × 0.03; 0.057 × 0.042; 0.038 × 0.019.

2. Axis (Fig. 4, *d-i*).

0.152 × 0.076; 0.114 × 0.065; 0.106 × 0.06; 0.106 × 0.075.

There can be no doubt that our specimens belong (1) to the Order Pseudaxonia, and (2) to the Family Sclerogorgiæ, which is thus defined by Bourne (Lankester's *Treatise of Zoology*, part ii., "The Anthozoa," p. 25): "The medullary mass forms a distinct axis consisting of closely packed elongate spicules with dense horny sheets. The axis does not contain solenia but is surrounded by longitudinal canals, *i.e.*, by large solenia which are connected with the zooid cavities by smaller ramifying solenia."

The position of the Gorgonellidæ, in general classification, is a matter of some difficulty, but in a memoir on that family about to be published, we have suggested that forms such as the one under consideration may be annectent between types like *Suberogorgia* and types like *Juncella*, but our present knowledge does not warrant the inclusion of this form in the

<sup>1</sup> The measurement of the triple-stars taken is the maximum, *i.e.*, from the extreme end of one "star" to the extreme end of an adjacent "star."

Gorgonellidæ. The axis is markedly "sclerogorgic" in that it consists of individual spicules, different from those in the cœnenchyma, embedded in a horny matrix. The horny substance, in which the spicules lie longitudinally, is deposited in the form of concentric laminae, but the same applies to the genus *Suberogorgia*, as was pointed out by Gray in his original description of this genus, where he says:—"Axis, pale brown, formed of rather loosely concentric fibrous laminae, containing a large quantity of calcareous matter."

The proportion of the horny material to the calcareous is, however, very much greater in the present case than in *Suberogorgia*; the nature of the colony is quite different; there is no trace of two main longitudinal canals larger than the others in the present specimen, and the spicules are very distinctive, both those of the axis and those of the cœnenchyma.

For these reasons it seems necessary to establish a new genus, which we propose to call *Dendrogorgia*, in the Family Sclerogorgidæ, Order Pseudaxonia.

The following generic diagnosis, based however on a single species, may be given:—

Colony very robust, slightly branched approximately in one plane; the branching is a false dichotomy. The axis is "sclerogorgic," and is moderately soft; it does not contain solenia, and is composed of concentric laminae, consisting of a horny matrix in which spicules are embedded longitudinally.

The spicules of the axis are smooth or warty, and very irregular in shape. The cœnenchyma is very thick, and is almost of a uniform thickness throughout. It is densely packed with small spicules which are predominately triple-star-shaped; double-stars also occur. The triple-stars are of two kinds—(1) those with short "shafts" and large, closely tuberculated "heads," and (2) those with long "shafts" and openly-warted "heads." The canal system is very definite; it consists of (1) an inner longitudinal series separating the axis from the cœnenchyma, and (2) an outer longitudinal series which is situated near the periphery. Uniting these there is a dense network of small transverse solenia. The polyps are disposed over the whole cœnenchyma; there is no distinct separation into verrucæ and anthocodia; they are capable of being completely retracted into the cœnenchyma when a small pore surrounded by an octoradiate structure is to be seen.

*Locality*.—Bird Island, E. by N.  $\frac{1}{4}$  N., 5 miles (Cape Colony); depth, 40 fathoms; bottom—mud.

## II.—Echinoidea and Asteroidea from the Mergui Archipelago and Moskos Islands, Lower Burma. By R. N. Rudmose Brown, D.Sc.

(Received 12th October 1909. Read 22nd November 1909.)

THE material which forms the subject of the present paper was collected by Mr James J. Simpson and myself, during our investigation of the pearl-oyster fisheries of the Mergui Archipelago on behalf of the Indian Government in 1907.

Previous to this, the only published record of Echinoids and Asterooids from the Mergui Archipelago was to be found in papers<sup>1</sup> by Prof. P. Martin Duncan and Mr W. P. Sladen, founded on material obtained by Dr John Anderson in 1882. From the Moskos Islands several species of Echinoderms are recorded by Dr A. R. S. Anderson in the Surgeon Naturalists Report for the season 1898-1899 (Report of the Marine Survey of India, 1899). The present collections would have been larger if time and opportunity had permitted, for the fauna of the Archipelago is clearly a rich one, but both Mr Simpson and myself had to concentrate all our attention on the pearl oysters and questions immediately relating to that subject: there was, in consequence, all too little time for general collecting. Some of the largest specimens, notably those of *Pentaceros superbus*, *P. lincki*, and *P. gracilis*, we could never hope to have obtained in perfect condition with a dredge; these we owe to our divers, whom we instructed to bring up anything they could find in addition to pearl and mother-of-pearl oysters. This is probably one of the first expeditions in which a diver has been employed to make zoological collections, and the success of the method, even more in other groups than in Echinoderms, should commend it to others.

My acknowledgments are due to Prof. F. Jeffrey Bell for his valuable opinion on certain species; to Prof. J. Arthur Thomson, who kindly gave me accommodation in his laboratory at Marischal College, Aberdeen; and to Dr W. S. Bruce, who was of great assistance to me in obtaining literature.

### ECHINOIDEA.

The present collection contains fifteen species, none of which are new. Dr Anderson, in 1882, collected six species, two of which, *Temnopleurus toreumaticus* (Klein), Agass., and *Arachnoides placenta* (Linn.), Agass., are not represented in this collection. The total number of species of Echinoids known from the Mergui Archipelago is, therefore, seventeen.

<sup>1</sup> "Echinoidea of the Mergui Archipelago," by P. M. Duncan and W. P. Sladen, *Jour. Linn. Soc. London Zool.*, xxi. (1889), pp. 316-319. "Asteroidea," by W. P. Sladen, *loc. cit.*, pp. 319-331.

The fifteen Echinoids in the present collection are as follows:—

1. *Phyllacanthus baculosus* (Lam.), A. Ag.
2. *Diadema saxatile*, Linn.
3. *Echinothrix turcarum*, Ret.
4. *Astropyga radiata*, Gray.
5. *Asthenosoma Grubei*, A. Ag.
6. *Echinometra lucunter*, de Blainv.
7. *Salmacis bicolor*, Agass.
8. *Salmacis Dussumieri*, Agass.
9. *Salmacis sulcata*, Agass.
10. *Salmacis globator* (Bell).
11. *Mespilia globulus*, Agass.
12. *Laganum depressum*, Less.
13. *Laganum decagonale*, de Blainv.
14. *Laganum* sp.
15. *Lorenia subcarinata*, Gray.

The most noteworthy species in this collection are *Asthenosoma Grubei* and *Salmacis globator*.

*A. Grubei*, of interest in itself as a specimen of a little known species, has an additional claim to notice since its occurrence in the Mergui Archipelago extends to the Indian Ocean the range of a species that was previously known only from the Philippines and Dutch East Indies.

*Salmacis globator* has been recorded previously from Singapore and the Pacific, but never from the Indian Ocean.

1. *Phyllacanthus baculosus* (Lam.), A. Ag.

A. Ag., Rev. Ech., p. 388.<sup>1</sup>

*Locality*.—XXIX,<sup>2</sup> High Peaked Island, coral reef.

A large specimen, 60 mm. in height and 75 mm. in diameter. Most of the spines are of a very light-green colour banded with faint purple.

Distributed from the Red Sea, Zanzibar, Mozambique, and Mauritius, to Timor and the Philippines.

2. *Diadema saxatile*, Linn.

A. Ag., Rev. Ech., p. 274.

*Localities*.—III., Iron Island, shore pools; XIV. and XXIX., Bushby Island and High Peaked Island, coral reefs.

<sup>1</sup> References are given only to Agassiz's *Revision*, except in the case of species described since the date of that work.

<sup>2</sup> These numbers refer to the Stations.

It is noticeable that at Iron Island this species flourishes in rock pools, away from any coral reefs, contrary to its usual habit.

Known from the Atlantic, Indian, and Pacific Oceans.

3. *Echinothrix turcarum*, Ret.

A. Ag., Rev. Ech., p. 416.

*Locality*.—VIII., Port Maria, Elphinstone Island, 3 fathoms, fine sand.

The spines of this species are but slightly hollow as a rule: in this specimen, however, they are hollow throughout and very nearly approach the spines of *E. calamaris*. The ambulacral areas are markedly gibbous near the abactinal area.

Height, 27 mm.; diameter, 55 mm.; longest spine, 56 mm.

Distributed in the Indian Ocean and Pacific to Japan and Fiji.

4. *Astropyga radiata*, Gray.

A. Ag., Rev. Ech., p. 420.

*Locality*.—XXXII., Bentinck Island, 29 fathoms, soft mud.

A single small specimen, almost bare of spines.

Known from Zanzibar and Mozambique to the Philippines.

5. *Asthenosoma Grubei*, A. Ag.

A. Ag., Proc. Amer. Acad., xiv. p. 200 (1879).

*Locality*.—XIV., Bushby Island, 15 fathoms, rock and sand.

A single dry specimen in perfect condition, agreeing with the "Challenger" specimen as described and figured by Sladen (*"Challenger" Reports*, iii. p. 82, and pls. xv., xvi., xvii., etc.). It may be identical with *Asthenosoma varium* from the China and Java Seas, but Grube's description of that species is too vague and general to be of much value to systematists.

Not previously known from the Indian Ocean, and apparently only recorded from the Philippines and Dutch East Indies.

6. *Echinometra lucunter*, de Blainv.

A. Ag., Rev. Ech., p. 431.

*Locality*.—VIII., Port Maria, Elphinstone Island, 3 fathoms, fine sand.

Two small specimens in perfect condition. The spines are light-green and olive-green respectively (in alcohol), and are tipped with straw colour; a few narrow abruptly towards their extremities.

Distributed in the Indian and Pacific Oceans.

7. *Salmacis bicolor*, Agass.

A. Ag., Rev. Ech., p. 471.

*Localities*.—XXXIII., Christmas Island, 23 fathoms, sand and mud; IX., Bentinck Island to Courts Island, 12 to 26 fathoms, coral and sand; XXV., Gregory Group, 4 to 14 fathoms, sand and shell; II., Iron Island, 10 to 25 fathoms, stones and mud.

In general appearance these specimens bear a strong resemblance to those which I have referred to *S. globator*, Bell, but on closer examination they prove to be distinct. The sutural furrows are marked, and the sutural pores conspicuous; the tubercles are prominent even above the ambitus; the spines are numerous all over the test, the ambital ones attaining a length of 15 mm.

Height,	30 mm.	27 mm.	24 mm.
Diameter,	43 mm.	41 mm.	34 mm.
Actinostome,	13 mm.	12 mm.	10 mm.

Recorded from the Western Indian Ocean, Ceylon, and the Philippines; and from King Island, Mergui Archipelago, by Dr Anderson.

8. *Salmacis Dussumieri*, Agass.

A. Ag., Rev. Ech., p. 473.

*Localities*.—XXXIII., Christmas Island, 23 fathoms, sand and mud; IX., Courts to Bentinck Islands, 12 to 26 fathoms, coral and sand; XVI., Alligator Rock, 8 to 18 fathoms, rock and sand; XXX., Fly Island (High Peaked Island), 8 fathoms, sand; XXV., Gregory Group, 4 to 14 fathoms, sand and shell.

A good series of this species, all with the spines complete. Spines spathiform and up to 17 mm. in length at the ambitus; much shorter, 5 mm., sharper and relatively stouter on the abactinal surface; on the actinal surface mostly spathiform, especially around the actinostome, and from 5 to 7 mm. in length. Only ambital and actinal spines banded with purple.

Height,	19 mm.	19 mm.	19 mm.	11 mm.
Diameter,	42 mm.	41 mm.	42 mm.	29 mm.

Recorded from the China Seas, the Philippines, and "East India Islands"; and from King Island, Mergui Archipelago, by Dr Anderson; also Mozambique.

9. *Salmacis sulcata*, Agass.

A. Ag., Rev. Ech., p. 476.

*Localities*.—IX., Bentinck to Courts Islands, 12 to 26 fathoms, coral and sand; XVIII., Off Paway Island, 10 to 21 fathoms, sand and shell; XVII., Sir

John Malcolm to Charlotte Islands, 18 fathoms, coarse sand; XXV., Gregory Group, 4 to 14 fathoms, sand and shell; XXIV., Cat and Kitten, 12 fathoms, rock and sand.

All small specimens, the largest being 38 mm. in diameter. In the largest the spines are tipped with violet; the smaller ones have them entirely white.

Height, 18 and 20 mm. Diameter, 37 and 38 mm.

Recorded from the Red Sea, Mozambique, and Ceylon, to the Philippines and Australia; and from King Island, Mergui Archipelago, by Dr Anderson.

#### 10. *Salmacis globator*, Bell.

Bell, P.Z.S. (1880), p. 431, pl. xli. figs. 2, 3, and 8.

*Localities*.—XVI., Alligator Rock, 8 to 18 fathoms, rock and sand; XXII.

Hastings Harbour, St Luke's Island, 15 to 20 fathoms, sand and shell.

These two specimens agree in all respects with F. Jeffrey Bell's description and figure of *S. globator*  $\beta$ . There can be no doubt as to the identity of the Mergui specimens, and the only difficulty that confronts one is the synonymy of the species (see F. P. Bedford, P.Z.S. (1900), p. 282, pl. xxii.). The primary spines are greenish-white and encircled with narrow bright red bands at irregular intervals; on the actinal surface they are more numerous and longer, attaining a length of 10 mm. around the actinostome; they are flattened at the tips.

Height,	41 mm.	36 mm.
Diameter,	59 mm.	57 mm.
Actinostome,	15 mm.	16 mm.

Professor Bell's *Salmacis alexandri* (*S. globator*  $\alpha$ ) (*loc. cit.*) is not represented in this collection.

Distributed from Singapore to the east coast of Australia, and possibly in the Korean Straits.

#### 11. *Mespilia globulus*, Agass.

A. Ag., Rev. Ech., p. 477.

*Localities*.—VIII., Port Maria, Elphinstone Island, 4 fathoms, sand; XX.,

High Island, 5 fathoms, sand and rock; XXV., Gregory Group, 4 to 14 fathoms, sand and shell.

The median tracts of the ambulacral areas are scarcely bare except in the largest specimens.

Not previously recorded from the Indian Ocean, but known from the Philippines, Japan, and the Sandwich Islands.

12. *Laganum depressum*, Less.

A. Ag., Rev. Ech., p. 518.

*Localities*.—VIII., Port Maria, Elphinstone Island, 3 fathoms, fine sand;  
XXXII., Bentinck Island, 29 fathoms, soft mud.

The edges of the larger specimens have decided re-entrant angles, especially posteriorly. A young specimen (22.5 mm. long) has the angular outline of the adult, but the edges are straight.

Known from Zanzibar and Mozambique to the Philippines and Australia; and collected by Dr Anderson at King Island, Mergui Archipelago.

13. *Laganum decagonale*, de Blainv.

Peronella decagonalis, A. Ag., Rev. Ech., p. 520.

*Localities*.—XXXII., Bentinck Island, 29 fathoms, soft mud; XIII., Maria Island, shore pools; XVIII., Off Paway Island, 10 to 21 fathoms, sand and shell; XXV., Gregory Group, 4 to 14 fathoms, sand and shell; XXII., Hastings Harbour, St Luke's Island, 15 to 20 fathoms, sand and shell; and XLI., Moskos Islands, 12 to 15 fathoms, sand and rock. The largest specimen has a longitudinal diameter of 108 mm.

The youngest specimens have an almost circular outline with a bare suggestion of the angles. A young denuded test (31 mm. diameter) from Hastings Harbour recalls *Clypeaster humilis*, but, I think, is referable to this species.

Distributed in the Bay of Bengal and the Western Pacific. Also recorded from Mozambique.

14. *Laganum* sp.

*Locality*.—XVIII., Off Paway Island, 10 to 21 fathoms, sand and shell.

Five small dead and denuded tests were found in the dredge; the largest has a longitudinal diameter of 17 mm. The test is orbicular and somewhat swollen; there are four genital pores.

These specimens seem to be identical with those described and figured by F. P. Bedford as *Laganum* sp., from Singapore and Malacca (*P.Z.S.* (1900), p. 285, pl. xxiii. fig. 7, *a* and *b*). They may or may not be the young of *L. depressum*.

15. *Lovenia subcarinata*, Gray.

A. Ag., Rev. Ech., p. 577.

*Locality*.—I., Tavoy Island, 10 fathoms, sand and shell.

Three individuals were obtained, of which the largest is 32 mm. long and 24 mm. broad.

Its occurrence in the Mèrgui Archipelago extends the range of the species, which was previously known only from the Philippines to China, Japan, and the Sandwich Islands, and Dutch East Indies. Later it has, however, been recorded from the Mozambique coast.

#### ASTEROIDEA.

Nineteen species of Asteroids were collected, including no new species but many new records for the Mergui Archipelago, and, in some cases, for the Indian Ocean. These collections have therefore not borne out Dr Anderson's belief of "a reasonable expectation that a number of new species may ultimately be found in the Mergui Archipelago." Dr Anderson<sup>1</sup> collected nine species, of which three were new. Of these nine species only four occur in the present collection, or, at the most, five, if we can include *Astropecten Hemprichii*, should it prove to be the same as *A. mauritanus*. None of Anderson's new species are included in our collection. The total number of Asteroids known from the Mergui Archipelago is therefore 24, or possibly 23. In addition, a species of *Culcita* was frequently seen on the coral reefs, but no specimen reached this country.

The Asteroids in the present collection are as follows :—

1. *Archaster typicus*, M. & T.
2. *Craspidaster hesperus* (M. & T.), Sladen
3. *Astropecten mauritanus*, Gray.
4. *Astropecten zebra*, Sladen.
5. *Astropecten polyacanthus*, M. & T.
6. *Luidia forcifer*, Sladen.
7. *Luidia maculata*, M. & T.
8. *Goniodiscus articulatus* (Linn.), Lütken.
9. *Stellaster inaei*, Gray.
10. *Anthenea flavescens* (Gray), Perr.
11. *Anthenea pentagonula* (Lam.), Perr.
12. *Pentaceros granulosus*, Gray.
13. *Pentaceros lincki* (de Blainv.).
14. *Pentaceros superbus*, Möbius.
15. *Pentaceros gracilis*, Lütken.
16. *Palmipes rosaceus* (Lam.), Duj. & Hupé.

<sup>1</sup> Jour. Linn. Soc. Lond. Zool., xxi. (1889), pp. 319-331.

17. *Fromia milleporella*, Gray.
18. *Retaster cribrosus* (von Mart.).
19. *Echinaster purpureus* (Gray), Bell.

The absence of any species of *Linckia* is noticeable, for this genus is widely diffused and common in many parts of the Indian Ocean. Three species constitute new records for the Indian Ocean, namely, *Craspidaster hesperus*, a Pacific species, and *Anthena flavescent* and *Pentaceros granulosus*, both Australian forms. *Pentaceros gracilis* is extremely abundant on the pearl banks of the Mergui Archipelago, and has since been noted in numbers on the pearl banks of the Mozambique coast of Africa; yet, as far as I can ascertain, it was previous to these discoveries looked upon as an Australian form; a fact which forcibly illustrates the poverty of our knowledge of the marine fauna of many parts of the Indian Ocean.

#### 1. *Archaster typicus*, M. & T.

Perrier, Révision de Stellérides,<sup>1</sup> Arch. de Zool. expér. et gén., v. (1875), p. 265.

*Locality*.—XVI., Alligator Rock, 8 to 18 fathoms, rock and sand.

Two specimens in which  $R=44$  and 46 and  $r=10$  and 9 respectively.<sup>2</sup> In the smaller specimen a single spine appears on one supero-marginal; otherwise the supero-marginals have no trace of spines. A similar occurrence in this species is noted by Lütken (*Vidensk. Medd.* (1864), p. 136), and by Sladen ("Challenger" Reports, xxx., p. 124).

This species is also recorded from the Mergui Archipelago by Dr Anderson in 1882. Widely distributed in Eastern Indian Ocean and Western Pacific.

#### 2. *Craspidaster hesperus* (M. & T.), Sladen.

Sladen, "Challenger" Reports, xxx. p. 177, pl. xvii. figs. 5-7; and pl. xviii. figs. 1-4.

*Locality*.—XXXII., Off Bentinck Island, 29 fathoms, soft mud and sand.

Two specimens agree with the young phase described by Sladen. The adpressed spinelets on the infero-marginal plates tend to fall off very readily, but their presence is quite evident in both specimens.

$$R=22 \qquad r=6.5.$$

Apparently not previously recorded from the Indian Ocean. Known from Japan to Singapore.

<sup>1</sup> In the case of species included in Perrier's *Révision*, I give no other reference than to his paper as a rule: the synonymy is therein discussed.

<sup>2</sup> All measurements are in millimetres.

3. *Astropecten mauritanus*, Gray.Perrier, *loc. cit.*, v. p. 279.

*Localities*.—Frequent on pearl banks throughout the Archipelago, in 5 to 25 fathoms, sand and rock.

$$R = 111 \quad r = 21.5 \quad R = 81 \quad r = 19.$$

Undoubtedly this species is very closely allied to *A. Hemprichii*, M. & T., despite de Lorient's belief that the two species cannot be confused (*Mém. Soc. Phy. Hist. Nat. Gen.*, t. xxix., No. 4, p. 74, and pl. xxi.). He lays stress on the absence of supero-marginal spines in the angles of *A. Hemprichii* and their presence in *A. mauritanus*, but this, as Jeffrey Bell has pointed out, is not a reliable character in *Astropecten*. It will not be surprising if the two species prove to be one and the same. I have named the Mergui specimens after careful comparison with specimens in the British Museum.

A new record for the Eastern Indian Ocean, but Dr Anderson collected *A. Hemprichii* in the Mergui Archipelago.

4. *Astropecten zebra*, Sladen.

Sladen, "Challenger" Reports, xxx. p. 212, and pl. xxxvi. figs. 3 and 4 ;  
pl. xxxix., figs. 7 to 9.

*Localities*.—IX., Courts Island to Bentinck Island, 12 to 26 fathoms, coral and sand ; XXV., Gregory Group, 4 to 14 fathoms, sand and broken shell.

Four specimens, the two larger of which are each in process of regrowing an arm.

$$R = 26 \quad r = 7.5 \quad R = 30 \quad r = 8 \quad R = 25 \quad r = 7 \quad R = 16.5 \quad r = 5.5.$$

A slight prominence in the centre of the upper surface of the disc appears as a conical beak in the smaller specimens; it is most prominent in the smallest. Of the supero-marginal plates, as many as the eight innermost on either side of each arm may bear spines, but of these the last two are very rudimentary. In the smallest specimen, one or two of the supero-marginals on each side of the median interradial line bear spines. Even in the larger specimens, however, the number of spines is variable, bearing out Jeffrey Bell's contention as to the absence of value of these in classification (Hornell and Herdman, *Ceylon Pearl Oyster Fisheries Report*, ii. p. 149). Bell thinks (*loc. cit.*) that *A. zebra* and *A. Hemprichii* are identical. They certainly approach one another very closely in their characters, but those which Bell figures (from photographs) as *A. Hemprichii* seem to be *A. zebra* and apparently were thus named by Sladen.

Known previously from Torres Strait and Ceylon.

5. *Astropecten polyacanthus*, M. & T.Perrier, *loc. cit.*, v. p. 275.*Locality*.—I., Tavoy Island, 8 fathoms, shelly sand and mud. $R = 15.5$        $r = 4$ .      Breadth of arm at base = 4.5.

A single specimen, apparently a young form, in which the spines of the ventral surface are scarcely developed. One supero-marginal on either side of the median interradial line bears a distinct tooth-like spine inclined slightly inwards.

The specimen seems to be referable to this species.

Recorded previously from the Red Sea, Zanzibar, and Mozambique, the Seychelles and Ceylon to Hong Kong, the Fiji Islands, and Port Jackson.

6. *Luidia forcifer*, Sladen.

Sladen, "Challenger" Reports, xxx. p. 258, pl. xlv. fig. 5, and pl. xlv. figs. 5 and 6.

*Locality*.—IX., Between Courts Island and Bentinck Island, 12 to 26 fathoms, coral and sand.

A single specimen, not of full growth, but which can be referred to this species.       $R = 30$        $r = 5$ .

Collected by Dr Anderson at King Island and at Sir William James Island in the Archipelago, and also known from Torres Strait and the Arafura Sea.

7. *Luidia maculata*, M. & T.Perrier, *loc. cit.*, v. p. 258.

*Localities*.—XVIII., Off Paway Island, 10 to 21 fathoms, sand and shell;  
XXV., Gregory Group, 4 to 14 fathoms, sand and shell.

Several young specimens, in the largest of which  $R = 62$  and  $r = 11$ .

Found by Dr Anderson at King Island. Also known from Mozambique to Madras, Manilla, and Japan.

8. *Goniodiscus articulatus* (Linn.), Lütken.

Lütken, Vidensk. Medd. (1864), p. 147.

*Locality*.—XLI., Moskos Islands, 12 to 25 fathoms, rock and sand.

A single dried specimen in which  $R = 70$ ,  $r = 35$ . Number of marginals, 14 to 15.

This specimen agrees with that collected by Dr Anderson at King Island in 1882 in having the interbrachial arc more rounded than in de Loriol's figure, and consequently the rays appear more well-defined (de Loriol, *Rec. Zool. Suisse*, t. i. p. 638, pl. xxxv., 1884).

Also known from Singapore, the Sunda Straits, and Western Australia.

There is quite evidently some confusion prevalent with regard to this species. Perrier ("Pédicellaires," *Ann. Sci. Nat.*, xii. (1869), p. 279) describes his *Goniodiscus articulatus*, Ed. P., which is certainly not *Goniodiscus articulatus*, Lütken, nor *Asterias articulata*, Linn. In his *Révision des Stellerides* (v. p. 91), Perrier reduces his *Goniodiscus articulatus* to *Anthenca pentagonula* (Lam.), and these are the same species, but *Goniodiscus articulatus* (Linn.), Lütken, is quite distinct.

#### 9. *Stellaster incei*, Gray.

Perrier, *loc. cit.*, v. p. 43.

*Localities*.—II., East of Iron Island, 10 to 25 fathoms, stone and mud; XXXIII., Christmas Island, 23 fathoms, sand and mud; IX., Between Courts and Bentinck Islands, 12 to 26 fathoms, coral and sand; XVIII., Off Paway Island, 10 to 21 fathoms, sand and shell; XXV., Gregory Group, 4 to 14 fathoms, sand and shell; XXII., Hastings Harbour, St Luke's Island, 15 to 20 fathoms, sand and shell.

The commonest asteroid in the Mergui Archipelago, and represented in this collection by an extensive series of specimens. Among these are certain ones which might be referred to *S. belcheri*, Gray, but the distinctive characters, never very marked, break down entirely in intermediate forms. It is therefore unjustifiable to separate the two species, and I have followed F. P. Bedford (*P.Z.S.* (1900), p. 294) in combining them under the first name.

The measurements of the largest and smallest are

$$R = 51 \quad r = 21 \quad R = 30 \quad r = 12.$$

Recorded from Sumatra and Singapore to Australia, and Korea, and Ceylon, but apparently rare in the Indian Ocean. A single one has been recorded from the Mozambique coast.

#### 10. *Anthenca flavescens* (Gray), Perr.

Perrier, *loc. cit.*, v. p. 92.

*Localities*.—II., East of Iron Island, 10 to 25 fathoms, stones and mud; XXV., Gregory Group, 4 to 14 fathoms, sand and shell.

In the largest specimen  $R = 50$  and  $r = 21$ .

The smallest specimen ( $R = 20$ ) from the Gregory Group shows a strong resemblance to a young form of *Anthenca* dredged by the "Challenger" in Torres Strait and referred provisionally by Sladen to *Anthenca tuberculosa*. Gray, *jur.* ("Challenger" *Reports*, xxx. p. 340, and pl. lvi. figs. 5 to 8). It

seems likely that both these young specimens from Torres Strait and the Mergui Archipelago belong to *A. flavescens*.

Previously recorded from Port Jackson and Freemantle.

11. *Anthenea pentagonula* (Lam.), Perr.

Perrier, *loc. cit.*, v. p. 90. *Goniodiscus articulatus*, Ed. P. (non Lütken) Pédicellaires, p. 279.

*Locality*.—XLI., Moskos Islands, 12 to 25 fathoms, rock and sand.

A single dried specimen in which  $R=120$ ,  $r=62$ . Number of marginal plates, 19. The arms are more acute than in the smaller specimens in the British Museum.

Known from Hong Kong, Madras, and N.W. Australia.

12. *Pentaceros granulosus*, Gray.

Perrier, *loc. cit.*, v. p. 52.

*Locality*.—IX., Between Courts and Bentinck Islands, 12 to 26 fathoms, coral and sand.

Several dried specimens.  $R=34$ ,  $r=14$ ;  $R=20$ ,  $r=7$ .

This species, which has the habit of a *Goniodiscus* rather than of a *Pentaceros* has been referred, from Singapore specimens, to *Goniodiscus articulatus* (Linn.), Lütken, by F. P. Bedford ("Malayan Echinoderms," *P.Z.S.* (1900), p. 294). The specimens in the present collection agree in all respects with certain ones from Singapore in the British Museum (*P. granulosus*), and in the meantime it may be advisable to keep the two species separate.

Apparently only recorded previously from Swan River and Freemantle, Western Australia.

13. *Pentaceros lincki* (de Blainv.).

*P. muricatus*, Perrier, *loc. cit.*, v. p. 55.

*Localities*.—XIV., Bushby Island, 15 to 23 fathoms, sand, shell, and rock;

XVII., Sir John Malcolm Island, 14 fathoms, sand and rock; XXV.

Gregory Group, 4 to 14 fathoms, sand and shell.

Very frequent on the pearl banks, where it is reputed by the divers to work havoc among the mother-of-pearl oysters. The collection includes a series of nine dried specimens of this variable species.

In some specimens the development of spines is very luxuriant, and in these cases the distal supero-marginals bear conspicuous spines: in other

cases, however, all the spines are more poorly developed, and those of the supero-marginals are not prominent. Two specimens have no central apical spine. The number of pedicellariæ which develop varies considerably. In some cases they are numerous on the reticulating bars of the dorsal ossicles up to the base of the lophial spines; in other cases they are rare even on the supero-marginals.

There is great variation in the colour of this species when alive. Most individuals are bright red or carmine except for the poriferous areas which are brown or grey, but many examples were noticed of a bright yellow or even orange colour.

Distributed from Mozambique and Zanzibar to Ceylon.

#### 14. *Pentaceros superbus*, Mobius.

Mobius, Abh. Geb. Naturw. Hamburg, Bd. iv., Abth., ii. p. 5.

*Locality*.—XIV., Bushby Island, 15 to 23 fathoms, sand and rock.

Two large dried specimens from Bushby Island pearl bank. These remarkably fine specimens are superior to any which I have seen in this country.

$R = 220$        $r = 63$ .      Width of arm at base = 70.

Previously known from Tuticorin and Sumatra.

#### 15. *Pentaceros gracilis* (Lütken).

Lütken, Vidensk. Medd. (1871), p. 260. Perrier, *loc. cit.*, v. p. 62.

*Localities*.—Abundant throughout the Archipelago and Moskos Islands on all pearl banks in 10 to 30 fathoms.

All the marginals are tuberculated. On the largest specimens the tubercles in the arc between the arms tend to split into two or three or more, especially on the infero-marginals. The lophial tubercles tend to be larger than others in many specimens. Tubercles occur at the corners of all the poriferous areas, especially in larger individuals: in smaller ones they do not all develop. Apical tubercles are specially prominent in smaller specimens: in larger ones other tubercles approximate to them in size. There are generally spines on the apical region, but sometimes only two or three around the anus.

There are many small valvular pedicellariæ on the marginals of both series and on the ventral surface.

In the two largest specimens     $R = 200$      $r = 66$ .     $R = 146$      $r = 60$ .

In life the colour of this animal is orange-red with the tubercles of a brighter orange colour and the poriferous areas greyer.

Recorded from Mozambique and East Australia; and Port Molle and Port Denison, Queensland.

15A. *Pentaceros gracilis* (Lütken), young.

*Locality*.—XIV., Bushby Island, 15 fathoms, rock and sand.

Apparently a young specimen.  $R = 65$ .

Disc not very high. Five large apical tubercles and three small ones around the anus.

The lophial line of tubercles distinct: tubercles few and small on a line on either side of the lophial line.

Supero-marginals with a single distinct tubercle generally absent on the most proximal but one; placed higher on the most proximal plate.

Infero-marginals with a similar tubercle, occasionally absent near the distal end.

Actinal surface with plates distinct, granulated, with a tendency to tubercles on the innermost ones.

Small valvular pedicellariæ on proximal plates of the row adjacent to the ambulacral groove, one on each plate.

Ambulacral armature: inside row of five or six spines, among which one or two seem decidedly larger: then two, large, stout, blunt: and finally an inconspicuous row of two or three small ones.

The specimen bears some resemblance to *P. chinensis*, Gray, but is probably a young form of *P. gracilis*.

16. *Palmipes rosaceus* (Lam.), Duj. & Hupé.

Perrier, *loc. cit.*, v. p. 210.

*Localities*.—XVII., Between Sir John Malcolm and Charlotte Islands, in 18 fathoms, coarse sand; XXV., Gregory Group, 4 to 14 fathoms, sand and shell.

Two damaged specimens, in the largest of which  $R = 105$  and  $r = 80$ .

Recorded from the Bay of Bengal and Japan.

17. *Fromia milleporella*, Gray.

Perrier, *loc. cit.*, iv. p. 437.

*Locality*.—XXII., Hastings Harbour, St Luke's Island, 15 to 20 fathoms, sand and shell; and XXX., Fly Island, 8 to 15 fathoms, rock and sand.

Two specimens in which the five arms are of unequal lengths.

$R = 50$  (longest arm) or  $38$  (shortest arm)  $r = 10$

$R = 60$   $r = 11$

In its somewhat irregularly arranged plates and unequal arms these recall the specimens from the Red Sea mentioned by Perrier.

Recorded from the Red Sea, Ceylon, Madagascar, and Mauritius to the Loo Choo Islands, the Moluccas, New Caledonia, Samoa, and the Fiji Islands.

18. *Retaster cribrosus* (von Mart.).

Sladen, "Challenger" Reports, xxx. p. 482, pl. lxxvi. figs. 3 and 4 ; and lxxvii. figs. 11, 12.

*Localities*.—II., Iron Island, 10 to 25 fathoms, stones and mud ; XXIII., Five Islands, 12 fathoms, rock and sand ; XXII., Hastings Harbour, St Luke's Island, 15 to 20 fathoms, sand and shell.

Several specimens, including a young one, in which  $R=18$  and  $r=7$ .

Known from Zanzibar and Mozambique to Ceylon, Singapore, the Philippines, and Samoa.

19. *Echinaster purpureus* (Gray), Bell.

*Echinaster fallax*, M. & T., Perrier, *loc. cit.*, iv. p. 370.

*Localities*.—IX., Courts to Bentinck Islands, 12 to 26 fathoms, coral and sand ; XVI., Alligator Rock, 8 to 18 fathoms, rock and sand ; XVII., Malcolm to Charlotte Islands, 18 fathoms, coarse sand ; XVIII., Off Paway Island, 10 to 21 fathoms, sand and shell ; and XXII., Hastings Harbour, St Luke's Island, 15 to 20 fathoms, sand and shell.

Nine specimens, varying in size from a very young one in which  $R=13$  to a large one in which  $R=82$  and  $r=6$ .

Throughout the Indian Ocean and South-Western Pacific.

(Issued separately, 17th February 1910.)

III.—Echinoidea from the Kerimba Archipelago, Portuguese East Africa (Mozambique). By R. N. Rudmose Brown, D.Sc.

(Received 12th October 1909. Read 22nd November 1909.)

THE collection of Echinoids described in the present paper was made by Mr J. J. Simpson, M.A., B.Sc., on the coast of Portuguese East Africa between latitudes  $10^{\circ} 42'$  S. and  $12^{\circ} 58'$  S. from September 1907 to May 1908. All were gathered on a coral bottom in depths under 20 fathoms. The collection comprises 21 species, and is chiefly interesting from a distributional point of view, our previous knowledge of the Echinoderm fauna of that particular part of the East African coast being very meagre indeed.

The 21 species of the present collection are all forms known from the tropical waters of the Indian and Pacific Oceans, with the exception perhaps of *Goniocidaris canaliculata*, which is characteristic of the colder southern circumpolar waters but has also been found at Zanzibar. Several species show an extension of range. *Lorenia subcarinata* until recently had only been recorded from Pacific waters. Mr Simpson and I found it at the Mergui Archipelago in 1907, and now it is recorded from the western shores of the Indian Ocean. Curiously enough the allied *L. elongata* does not occur among these specimens nor was it found in the Mergui Archipelago, although more than once it has been recorded from the Indian Ocean.

*Chaetodiadema granulatum* is one of the "Siboga" species described from Dutch East Indian waters. *Brissopsis luzonica* is another Pacific species which previously had not been recorded from the Indian Ocean. Otherwise the facies of this collection is very similar to that of the Echinoid fauna of the Indian Ocean generally. The complete list of the species is as follows:—

1. *Phyllacanthus baculosus* (Lam.), A. Ag.
2. *Phyllacanthus verticulata*, A. Ag.
3. *Goniocidaris canaliculata*, A. Ag.
4. *Echinothrix turcarum*, Ret.
5. *Astropyga radiata*, Gray.
6. *Chaetodiadema granulatum* Mortensen.
7. *Echinometra lucunter*, de Blainv.
8. *Echinostrephus molare*, A. Ag.
9. *Microcyphus maculatus*, Agass.
10. *Salmacis bicolor*, Agass.
11. *Salmacis Dussumieri*, Agass.
12. *Trochmæustes pilcolus*, Agass.

13. *Clypeaster scutiformis*, Lam.
14. *Clypeaster humilis*, Agass.
15. *Laganum depressum*, Less.
16. *Laganum decagonale*, de Blainv.
17. *Echinodiscus auritus*, Leske.
18. *Maretia planulata*, Gray.
19. *Lovenia subcarinata*, Gray.
20. *Brissopsis luzonica*, A. Ag.
21. *Schizaster gibberulus*, Agass.

In addition, *Diadema saxatile*, Linn. was noted as being very common all along the coast but no specimen was collected.

I must take this opportunity of expressing my indebtedness to Professor J. Arthur Thomson, for the use of a laboratory in the University of Aberdeen; to Professor F. Jeffrey Bell, for facilities in comparing specimens with those in the British Museum; and to Mr James Ritchie, B.Sc., for assisting me in getting access to literature bearing on the subject.

#### 1. *Phyllacanthus baculosus*, A. Ag.

A. Ag., Rev. Ech., p. 388.<sup>1</sup>

*Locality*.—III., Mtundo Bay, sand, shell, and coral, 6 fathoms.

One young specimen, 14 mm. in diameter. A few spines, smooth and without serration: all banded with violet and of the characteristic coloration at the base.

Two larger ones, 23 mm. in diameter, with spines up to 37 mm.

*Distribution*.—Mauritius, Mozambique, Zanzibar, and the Red Sea to Mergui, Timor, and the Philippines.

#### 2. *Phyllacanthus verticulata*, A. Ag.

A. Ag., Rev. Ech., p. 392.

A small specimen from no precise station: very fine spines.

*Distribution*.—Indian Ocean.

#### 3. *Goniocidaris canaliculata*, A. Ag.

A. Ag., Rev. Ech., p. 395.

*Localities*.—IX., Ibo Bay, Matemo Island; I., Tunghi Bay, sand, mud, and shell, 5 to 18 fathoms; III., Mtundo Bay, sand, shell, and coral, 6 fathoms; XI., Manangoroshi Point to Lurio Point, coral reefs.

<sup>1</sup> References are to Agassiz's *Revision* only for all species included in that work.

Ten specimens in all. The spines vary considerably: they are all fluted, but the conspicuous serrations on some tend to disguise this character: they are all blunt and banded with violet brown: the larger ones tend to be swollen in the middle.

Height,	15 mm.	11 mm.
Diameter,	26 mm.	17 mm.
Spine,	20 mm.	12 mm.

*Distribution*.—Fuegia, Cape Horn, Falkland Islands, Heard Island, Kerguelen, Australia, Natal, and Zanzibar. On the whole apparently a cold-water species.

#### 4. *Echinothrix turcarum*, Ret.

A. Ag., Rev. Ech., p. 416.

*Locality*.—X., Montepes Bay, sand and mud, 5 to 22 fathoms.

A small specimen whose height and diameter are 7 and 15 mm. respectively; the longest spine is 22 mm. In so young a specimen as this there might well be room for doubt whether it belonged to *E. turcarum* or to *E. calamaris*. The spines are long, hollow throughout, and delicate, quite characteristic of *E. calamaris*. On the other hand, the tuberculation and the character of the apical system are in favour of *E. turcarum*. Moreover, in specimens of this species from the Mergui Archipelago, the spines are delicate and hollow throughout like those of *E. calamaris* rather than those generally found in *E. turcarum*.

*Distribution*.—Indian Ocean and the Pacific to Japan and Fiji.

#### 5. *Astropyga radiata*, Gray.

A. Ag., Rev. Ech., p. 420.

*Localities*.—III., Mtundo Bay, sand, shell, and coral, 6 fathoms; X.,

Montepes Bay, sand and mud, 5 to 22 fathoms.

Five small specimens which, although young, show no departures from the well-defined characters of the adult. The outline from above is pentagonal. In the living animal the spines are brown with white bands.

Height,	11.5 mm.	10.5 mm.	?
Diameter,	27.0 mm.	31.0 mm.	33 mm.

The younger specimens are naturally, considering the flexible nature of the test, more rigid and consequently are relatively higher than the older ones.

*Distribution*.—Throughout the Indian Ocean, in the Dutch East Indies, and in the Philippines.

6. *Chaetodiadema granulatum*, Mortensen.

Mortensen, Vidensk. Medd. (1903).

De Meijere, Die Echinoidea der Siboga-Expedition, Mon. xliii., Résultats des Explorations du Siboga, 1904, p. 54 and plates.

*Locality*.—XIII., Pemba Bay, mud, 10 to 20 fathoms.

Three specimens are referable to this little known species, although I have had to rely on Mortensen's and de Meijere's descriptions in default of actual specimens for comparison. De Meijere's coloured plate (*loc. cit.* xi. 101) does not agree accurately with his own description of the species in tuberculation and spinulation. The specimens before me have been in spirit for about a year and consequently show practically no coloration.

Diameter.	Height.	Spines.	Dia. Act. sys.	Dia. Abact. sys.	Dia. Anal sys.
55 mm.	11.5 mm.	12 mm.	8.5 mm.	17 mm.	6.0 mm.
45 mm.	10.5 mm.	24 mm.	8.5 mm.	14 mm.	5.5 mm.
43 mm.	10.0 mm.	21 mm.	9.0 mm.	15 mm.	4.5 mm.

The "Siboga" specimens were collected in the Sunda and Banda Seas and vicinity.

7. *Echinometra lucunter*, de Blainv.

A. Ag., Rev. Ech., p. 431.

*Localities*.—IX., Ibo Bay, around Matemo Island, and between Matemo Island and mainland.

Several specimens, including a very young one. This species varies considerably in colour when alive. A deep purple is commonest, but individuals are often found of a dark olive-green and "black ones are seen not rarely." It was found in the usual habitat, burrowing in coral and coral rock.

*Distribution*.—Indian and Pacific Oceans.

8. *Echinostrephus molare*, A. Ag.

A. Ag., Rev. Ech., p. 457.

Three small specimens from no precise locality.

*Distribution*.—Indian and Western Pacific Oceans.

9. *Microcyphus maculatus*, Agass.

A. Ag., Rev. Ech., p. 466.

*Locality*.—II., Maiyapa Bay, sand, mud, and coral, 10 fathoms.

Three specimens, two of which are complete. The test is markedly pentagonal, but the interradius can scarcely be said to be re-entrant as Agassiz describes it in a specimen of 29 mm. (*loc. cit.*), although, when not denuded of spines, the animal gives such an appearance owing to the bare interambulacral areas. The bare interambulacral spaces extend to the poriferous areas and to the actinostome.

Heights, 21 and 25 mm.; Diameters, 33 and 36 mm.

*Distribution*.—Zanzibar and Mayotte, Moluccas, Australia, Navigator Islands, and Japan.

#### 10. *Salmacis bicolor*, Agass.

A. Ag., Rev. Ech., p. 471.

*Locality*.—VII., Pekawi Bay, exposed coral reef.

A single fine individual belongs to this species. The spines below the ambitus are short and stout; they are flattened at their distal ends, increasingly so towards the actinostome where they are spathiform. In colour they are light purple banded with yellowish green. On the abactinal surface the spines are shorter and sharp, passing from light red at their bases to bright purple, generally with one or more yellowish green bands.

Height, 41 mm. Diameter, 35 mm. Spine 14 mm.

*Distribution*.—Indian Ocean and to the Philippines.

#### 11. *Salmacis Dussumieri*, Agass.

A. Ag., Rev. Ech., p. 473.

*Localities*.—III., Mtundo Bay, sand, shell, and coral, 6 fathoms; VI., Kero-Nyuni Bay, sand, 5 to 10 fathoms.

Several fine specimens of various sizes, of which the largest has a diameter of 66 mm., a height of 33 mm., and ambital spines of 16 mm. The spines of the abactinal surface are relatively short, sharp, and evenly tapering to a point; those of the actinal surface are a little longer, blunt, and flattened; while the ambital spines in three or four horizontal rows are long, stout, and uniform in diameter throughout and fashioned like a gouge at the ends. These differences among primary spines are less marked in smaller specimens, but do exist. The shorter spines are green, faintly banded with purple; but the ambital spines tend to be very light purple, banded faintly with green.

*Distribution*.—China Seas to the Philippines, Dutch East Indies, and the Mergui Archipelago. These specimens seem to extend the range.

12. *Toxopneustes pileolus*, Agass.

A. Ag., Rev. Ech., p. 497.

*Localities*.—I., Tunghi Bay, sand, mud, and shell, 5 to 18 fathoms; III., Mtundo Bay, sand, shell, and coral, 6 fathoms; VI., Kero-Nyuni Bay, sand, 5 to 10 fathoms; IX., Ibo Bay, Matemo Island.

A large series of specimens which shows considerable variety in shape; some specimens are more globular, others are more compressed. But the globular shape is not a development of age for it occurs in some small and obviously young individuals. In outline the test from above is often decidedly pentagonal, less often almost circular. The ambulacral areas are slightly gibbous around the apical system. The actinal surface is only very slightly concave. The spirally arranged bands of colour mentioned by A. Agassiz (*loc. cit.*) are not obvious in these specimens.

Height (mm.)	28	26	22	20	20	17	15	11
Diameter (mm.)	39	35	29	29	26	26	21	15

*Distribution*.—Indian and Pacific Oceans.

13. *Clypeaster scutiformis*, Lam.

A. Ag., Rev. Ech., p. 512.

*Localities*.—X., Montepes Bay, sand and mud, 5 to 22 fathoms; XIII., Pemba Bay, mud, 10 to 20 fathoms.

A large and a small specimen. The outline of the former is decidedly pentagonal with rounded edges. The abactinal surface, from the swollen border, is convex but slightly flattened again at the apex. The extremities of the poriferous zones of the petals are a little concave.

Height, 11 mm.	Long. dia., 51 mm.	Trans. dia., 42 mm.
" 7 mm.	" " 31 mm.	" " 21 mm.

*Distribution*.—Japan, Formosa, Malay Archipelago generally, and Indian Ocean including Rea Sea, Ceylon, Mauritius, and Ibo.

14. *Clypeaster humilis*, Agass.

A. Ag., Rev. Ech., p. 510.

*Locality*.—II., Maiyapa Bay, sand, mud, and coral, 10 fathoms.

Several young individuals having the characteristic form of the adult. Their slightly pentagonal outline gives them a strong resemblance to certain species of *Laganum*.

*Distribution*.—Western Pacific and Indian Oceans.

15. *Laganum depressum*, Less.

A. Ag., Rev. Ech., p. 518.

*Localities*.—II., Maiyapa Bay, sand, mud, and coral, 10 fathoms; III., Mtundo Bay, sand, shell, and coral, 6 fathoms; VI., Kero-Nyuni Bay, sand, 5 to 10 fathoms.

Many specimens of various ages. In shape these specimens show many of the variations in outline habitual in this species: the truncated angles give a sub-decagonal or sometimes almost orbicular outline. The greatest transverse diameter is just anterior to the anterior pair of ambulacra in the largest specimen; in the smaller ones, it tends to run posterior to them or across the apex: this is not in accordance with what A. Agassiz describes (*loc. cit.*). In the larger specimens, the petals are relatively shorter than in the young, and in the largest specimen of all the margin of the test is distinctly swollen. In this specimen the posterior sides tend to show re-entrant angles, and on one side the test has evidently been damaged and partial regeneration, at least to the extent of the upper and lower surfaces fusing, has taken place.

The largest specimen has these dimensions:—

Long. dia., 68 mm.      Length, ant. pair ambulacra, 17 mm.

Trans. dia., 65 mm.      Length, odd ambulacrum, 18 mm.

*Distribution*.—Zanzibar, Mergui, Australia, the Philippines, and Fiji Islands.

16. *Laganum decagonale*, de Blainv.

A. Ag., Rev. Ech., p. 520

*Locality*.—III., Mtundo Bay, sand, shell, and coral, 6 fathoms.

A single dead specimen rather more oval than decagonal in outline.

*Distribution*.—Western Pacific and Bay of Bengal.

17. *Echinodiscus auritus*, Leske.

A. Ag., Rev. Ech., p. 531.

*Localities*.—Kifuki Island and Foomo Island.

Only one specimen was collected but it is a very perfect one. The outline, especially posteriorly, is somewhat irregular. The edge on one side anterior to the lunule is very ragged and gives the impression that it has suffered injury and has undergone a certain degree of regeneration. The length of the lunule is 40 mm., the total distance from the edge of the test to the apex is 92; this is a longer lunule than generally is found. The anus, however, is as usual in a line with the inner ends of the lunules.

The measurements of this fine specimen are worth recording.

Height, 13 mm. Long. dia., 158 mm. Trans. dia., 147 mm.  
 Post. petals, 29 mm. Odd petal, 34 mm. Width, porif. zone, 5 mm.  
 Width, inter. porif. zone, 5.5 mm. Anus from edge of test, 37 mm.  
 Mouth from anterior edge, 76 mm.

*Distribution*.—Indian Ocean, especially the west, Amboina, Philippines, and Straits of Macassar.

18. *Maretia planulata*, Gray.

A. Ag., Rev. Ech., p. 570.

*Localities*.—III., Mtundo Bay, sand, shell, and coral, 6 fathoms; VI., Kero-Nyuni Bay, sand, 5 to 10 fathoms; X., Montepes Bay, sand and mud, 5 to 22 fathoms.

A series of seven specimens of various ages. All the specimens seem to be a little flatter than is usual in this species. The slight anterior ambital groove, never at all prominent, is practically indistinguishable in the largest specimens. The variations in colour (in spirit specimens) common in this species are not noticeable. A uniform straw colour prevails, except in one specimen, in which the lateral petals on one side show a certain amount of violet brown coloration, and the same colour appears on the primary tubercles. The primary spines in this case are banded with faint violet brown.

Height, 16 mm. Long. dia., 68 mm. Trans. dia., 54 mm.  
 „ 12 mm. „ „ 46 mm. „ „ 37 mm.

*Distribution*.—Western Pacific through the Indian Ocean to Zanzibar.

19. *Lovenia subcarinata*, Gray.

A. Ag., Rev. Ech., p. 577.

*Localities*.—VI., Kero-Nyuni Bay, sand, 5 to 10 fathoms; XIII., Pemba Bay, mud, 10 to 20 fathoms.

Several fine specimens.

The specific characters which distinguish this species from *L. elongata* in young specimens—the sub-triangular actinostome, the outward slope from the anal system to the abactinal surface, and the triangular actinal plastron—are maintained in the older ones. More mature specimens show no departure from the small number of primary tubercles on the abactinal surface in the anterior half of the postero-lateral interambulacra.

Height, 19 mm.	Length, 46 mm.	Diameter, 35 mm.
„ 19 mm.	„ 47 mm.	„ 34 mm.
„ 14 mm.	„ 36 mm.	„ 26 mm.
„ 11 mm.	„ 29 mm.	„ 22 mm.

*Distribution*.—Only known from the Western Pacific—Japan to the Sandwich Islands—and the Mergui Archipelago.

20. *Brissopsis luzonica*, A. Ag.

A. Ag., Rev. Ech., p. 593.

*Locality*.—V., Namegus Bay, mud and rocks.

A solitary injured specimen belongs to this species. The anal plastron is missing. The bare areas on the actinal surface with undiminished width run from the mouth to the sub-anal plastron.

Height, 23 mm. Long dia., 45 mm. (approx.). Trans. dia., 38 mm.

*Distribution*.—Western Pacific, from New Zealand to Japan. This record gives a great extension of range.

21. *Schizaster gibberulus*, Agass.

A. Ag., Rev. Ech., p. 612.

*Locality*.—VI., Kero-Nyuni Bay, sand, 5 to 10 fathoms.

A single specimen. This species strongly resembles *S. canaliferus*.

The points of difference between the two species enumerated by Agassiz (*loc. cit.*) are not of great value, for all are very slight. If anything, the test of *S. gibberulus* is narrower and more arched, the apical system is slightly more anterior, and the bare abactinal surfaces are larger than in *S. canaliferus*. The tubercles of the actinal plastron cannot be said to be "coarser" and "more distinct," but the spines on the anterior half of the plastron are conspicuously spatulate. The species is certainly very closely allied to the Mediterranean *S. canaliferus*.

Height, 18 mm. Length, ant. petals, 16 mm.

Long. dia., 42 mm. Length, post. petals, 7 mm.

Trans. dia., 35 mm. Length, odd petal, 22 mm.

*Distribution*.—Red Sea and Ceylon.

IV.—**Asteroidea of Portuguese East Africa, collected by Jas. J. Simpson, M.A., B.Sc. (1907-1908). By Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose Brown, D.Sc.**

(Received 12th October 1909. Read 22nd November 1909.)

THE present collections were made on the Mozambique Coast of Portuguese East Africa, between September 1907 and May 1908. The portion of the coast on which faunistic work was done extends from near Cape Delgado in 10° 42' S., to Pemba Bay (Maunhane Point), 12° 58' S.

Very little work of this nature has been done on the western shores of the Indian Ocean, so that, although the collections made by the R.I.M.S. "Investigator" have done much to elucidate the fauna of the eastern side, our knowledge of the fauna of the east coast of Africa is very scanty.

The present collections therefore may help in some measure to fill in many gaps in our knowledge, both of the Indian Ocean fauna in general and in the distribution of many tropical forms in particular.

The collection of Asteroids consists of fourteen named species, but in addition to these we have described four species which we have at present refrained from naming. The latter include two species of *Pentaceros* and one of *Anthenca*; they are probably all young forms, so that although it has been impossible to refer them to any known species we do not feel justified in describing them as new. A study of different stages of growth, in other species of Asteroids, has convinced us that it is almost impossible to be certain of any species from a young specimen, and we strongly agree with Professor F. Jeffrey Bell that the application of new names to what may be young and immature stages is a course to be thoroughly condemned. A very good example of this is the species *Linckia marmorata*, which we have here described in some detail, as from the original description, based on a young specimen, it is almost impossible to identify mature individuals.

We have, however, given short descriptions of the essential diagnostic features of these young forms, as they may, by comparison with others, help to form a series of developmental stages in definite species.

We have attempted to show the geographical range of those species which occur on this coast. *Archaster angulatus* is here recorded for the first time from the western side of the Indian Ocean; and *Luidia aspera* appears to be new for the East coast of Africa.

The bathymetrical range in distribution and the nature of the associated bottom has also been recorded when possible, and a comparison made with other records.

Numerous observations on colour schemes have been given, and these,

though often ignored by the cabinet zoologist, are of great significance to the field biologist, and show the futility of basing specific characteristics on colour. Very good examples of this are seen in species of *Pentaceros* and *Culcita*.

We would like here to draw attention to a peculiar association or commensalism which, although it has been observed in Holothurians, has so far escaped notice in Asteroids, viz., that between a species of *Fierasfer* (as yet unidentified) and *Pentaceros lincki*.

While dissecting specimens of this species of starfish for drying, we were surprised to find occasionally a small *Fierasfer* ALIVE; careful dissection showed that these fish, occasionally in pairs, inhabited the stomach of the starfish, but were quite healthy and normal; in fact, we were able to keep them alive for some time in tanks. On placing some of these large starfish in the same tanks, it was possible to watch the *Fierasfers* passing out and in at the "mouth" of the *Pentaceros*. This disappearance and reappearance continued daily, so that we feel quite in a position to say that it is another example of commensalism, similar to that between fish and Holothurians, added to our knowledge of "associations."

Several very interesting specimens of *Linckia diplax* showing different stages in the regeneration of lost arms occur in the collection. Especially noteworthy are the comet-forms.

We are glad to have this opportunity of expressing our indebtedness to Professor J. Arthur Thomson, for kindly granting us laboratory accommodation in his department in the University of Aberdeen, as well as for other facilities; and we wish also to thank Professor F. Jeffrey Bell, for allowing us to compare our specimens with those in the British Museum, and for the interest he has taken in the collection.

For general utility we have adopted the classification given by Sladen in his report on the "Challenger" asteroids (*"Challenger" Reports, Zoology, vol. xxx.*), although a better classification has since been published in Bronn's *Thierreich*.

In accordance with the former, the following table shows the general relationships of the various genera and species reported upon :—

CLASS ASTEROIDEA.

Sub-Class Euasteroidea, Sladen.

Order I. PHANEROZONIA, Sladen.

Family ARCHASTERIDÆ.

Sub-Family ARCHASTERINÆ.

*Archaster angulatus*, M. and T.

## Family ASTROPECTENIDÆ.

## Sub-Family ASTROPECTENINÆ.

*Astropecten Henprichii*, M. and T.„ *polyacanthus*, M. and T.

## Sub-Family LUIDINÆ.

*Luidia maculata*, M. and T.„ *aspera*, Sladen.

## Family PENTAGONASTERIDÆ, Perrier.

## Sub-Family GONIODISCINÆ.

*Stellaster inaei*, Gray.

## Family ANTHENEIDÆ.

*Anthenea* sp.

## Family PENTACEROTIDÆ.

*Pentaceros lincki*, (de Blainv.).„ *superbus*, Möbius.„ *gracilis*, Lütken.

„ sp.

„ sp.

*Culecita schmideliana* (Retz.).

„ sp.

## Order II. CRYPTOZONIA, Sladen.

## Family LINCKIIDÆ.

## Sub-Family LINCKIINÆ.

*Ophidiaster cylindricus* (Lam.), M. and T.*Linckia diptae*, M. and T.„ *marmorata* (Michelin).*Nardoa cariolata*, Gray.

## Family PTERASTERIDÆ.

## Sub-Family PTERASTERINÆ.

*Retaster cribrosus* (von Mart.).

**Archaster angulatus, M. and T.**

This typically shallow-water species is represented in the collection by four specimens of different size, all captured in the same haul of the dredge in Mtundo Bay, between the islands of Wamizi and Kifuki.

Their measurements<sup>1</sup> are as follows:—

$R = 58$	$r = 10$
$R = 55$	$r = 9.5$
$R = 36$	$r = 7$
$R = 27$ to $29$	$r = 6$

$R$  therefore varies from  $4.8r$  to  $5.8r$ .

In the first and largest specimen one arm has evidently been regenerated.

This is the first record, as far as we can discover, from the extreme western side of the Indian Ocean.

*Locality*.—Station III., Mtundo Bay (Wamizi Island to Kifuki Island).

*Previously recorded from*—West Australia; Freemantle; Port Darwin; Torres Strait; New Guinea; Philippines; Fiji Is.; Mauritius.

**Astropecten Hemprichii, M. and T.**

Several specimens of various ages and slightly different in superficial appearance represent this species. They were obtained in three separate localities, viz., Tunghi Bay, Mtundo Bay, and Montepes Bay. They agree exactly with those of the same species in the British Museum, collected by H.M.S. "Alert" on the Mozambique Coast. One specimen has been regenerating three arms from the disc.

*Localities*.—Station I., Tunghi Bay; Station III., Mtundo Bay (Wamizi Is. to Kifuki Is.); Station X., Montepes Bay.

*Previously recorded from*—Mozambique Coast; Red Sea; Mauritius; Ceylon; Tuticorin; Mergui Archipelago.

**Astropecten polyacanthus, M. and T.**

In the specimens, which we have identified with this species, the first supero-marginal plate is strongly armed with a vertical spine. The second supero-marginal on each side of the median interrarial line is devoid of a spine, while the remainder have the same structure as the first.

Sladen draws attention to a specimen in which this characteristic absence is not pronounced.

This species is fairly abundant on the coast, and its distribution is

<sup>1</sup> All measurements are in millimetres.

interesting. It is a typically shallow-water species, as the following bathymetrical notes will show :—

China, . . . . .	Beach.
Japan, . . . . .	5 to 25 fathoms.
Admiralty Islands, . . . . .	16 to 25 fathoms.
Port Jackson, . . . . .	2 to 11 fathoms, and 6 to 15 fathoms.
Mergui Archipelago, . . . . .	8 fathoms.
East Africa, . . . . .	6 to 12 fathoms.

*Locality*.—Station VI., Kero-Nyuni Bay, near Ras Pekawi.

*Previously recorded from*—Japan; China; Fiji Is.; Admiralty Is.; Port Jackson; Banda Sea; Arafura Sea; Macclesfield Bank; N.W. Australia; New Zealand; Andaman Is.; Mergui Archipelago; Ceylon; Seychelles; Amirante Is.; Mauritius; Zanzibar; and the Red Sea.

#### **Luidia maculata, M. and T.**

This species is represented by two specimens: the first, from Mtundo Bay, has seven arms; and the second, which is immature, has five complete arms, and three being regenerated from the disc.

The diagnostic characters in this species seem to be fairly constant, and our specimens agree very well with those previously described.

*Locality*.—Station III., Mtundo Bay (Wamizi Is. to Kifuki Is.); Station VI., Kero-Nyuni Bay.

*Previously recorded from*—S. Japan; Philippines; Singapore; Malacca; Macclesfield Bank; Mergui Archipelago; Tuticorin; and Mozambique.

#### **Luidia aspera, Sladen.**

This is a very distinct species, and we have no hesitation in referring our specimens to it. It is characterised by the form of the paxillæ and by the armature of the infero-marginal plates. The species is represented by one specimen from Tunghi Bay, and several detached arms which were obtained in a different haul of the dredge near the same place.

The following are the measurements of the complete individual :—

$$R = 145 \quad r = 16 \quad R = 9r.$$

Sladen, in describing this species, gives  $R = 7.5 r$  and  $R = 8.5 r$ . He also remarks that the number of arms varies from 8 to 10, but in the above specimen the number was 7, so that this feature cannot be regarded as specific.

The bathymetrical distribution of this species shows a considerable range. The specimens from the Admiralty Islands were obtained in from 10 to 150

fathoms, whereas those on the East Coast of Africa were dredged in 9 to 15 fathoms.

*Locality*.—Station I., Tungshi Bay.

*Previously recorded from*—Philippines; Admiralty Is.; Macclesfield Bank.

***Stellaster incei*, Gray.**

This species is represented by a single specimen, in which  $R=285$  and  $r=10$ . The nature of the bottom on which a certain species exists is always interesting, inasmuch as it has often a distinct bearing on the individual specimens; but *S. incei* does not seem to be associated with any particular kind of bottom. At Mergui we found it occurring on—(1) mud and stones; (2) sand and mud; (3) coral and sand; and (4) sand and shell.

Its bathymetrical distribution is, however, restricted. The following records are noteworthy:—East Africa, 3 to 15 fathoms; Torres Strait, 6 to 8 fathoms; Arafura Sea, 28 fathoms; Philippines, 18 fathoms; Port Molle, 5 to 11 fathoms; Port Denison, 6 fathoms; Ceylon, up to 40 fathoms.

*Locality*.—Station VI., Kero-Nyuni Bay.

*Previously recorded from*—Korea; Singapore; North-West Australia; Port Curtis and Albany Island; and Mergui Archipelago (in addition to the above).

***Anthenea* sp.?**

There occur in the collection seven small specimens which we have referred to the genus *Anthenea*. They are all immature, and as we were unable to identify them with any known species, we have refrained from establishing a new species to include them. The following notes, however, may be of interest:—

$R=42$	$r=18$	$R=2\cdot3\ r$
$R=41$	$r=18$	$R=2\cdot3\ r$
$R=41$	$r=17$	$R=2\cdot4\ r$
$R=39$	$r=17$	$R=2\cdot3\ r$
$R=33$	$r=15$	$R=2\cdot2\ r$
$R=29$	$r=13$	$R=2\cdot2\ r$
$R=28$	$r=12$	$R=2\cdot3\ r$

There are nine marginal plates, excluding the unpaired terminal one; these are rectangular in shape and bear no pedicellariæ.

The supero-marginal plates are tuberculated; all, except those in the arcs, bear two tubercles, while three or four are not infrequent; the tubercles are arranged transversely. The infero-marginal plates bear spines only towards the extremities of the arms; three spines sometimes occur, either clustered or disposed longitudinally, never transversely.

The lophial line is composed of about 17 to 19 rounded plates; the proximal 5 of these bear tubercles, while the innermost of each line has a very large tubercle; a distinct pentagonal area is thus enclosed. The arrangement of the plates within this area is irregular; a few sometimes bear minute tubercles.

The madreporic is lozenge-shaped, and lies between the two adjacent plates which form one of the angles of the pentagon.

Valvular pedicellariæ occur in a discontinuous row on each side of the lophial line, while a few are also scattered on the interlophial plates and in the pentagonal area.

On the ventral surface the granulation is not prominent, and the plates are distinct. A definite line of valvular pedicellariæ extends on either side of the ambulacral groove; these lie usually longitudinally, but occasionally oblique. Larger forms also occur, scattered on other plates.

The ambulacral armature appears to consist of a single series, but near the apex of the arms a trace of a second series of spines is discernible. Each plate bears four almost equal spines; these are obtuse, flattened at the tips, and arranged in a palisade.

*Locality*.—Station X., Montepes Bay.

***Pentaceros lincki*,<sup>1</sup> de Blainville.**

*Locality*.—Stations I. to X., Bottom—sand, or sand and rock.

*Previously recorded from*—Mergui; Tuticorin; Ceylon; Mozambique; and Zanzibar.

***Pentaceros superbus*,<sup>1</sup> Möbius.**

*Locality*.—Stations I. to X., Bottom—sand, or sand and rock.

*Previously recorded from*—Tuticorin; Mergui; Sumatra.

***Pentaceros gracilis*,<sup>1</sup> Lütken.**

*Locality*.—Stations I. to X., Bottom—sand, or sand and rock.

*Previously recorded from*—Mergui; East Australia; Port Molle and Port Denison, Queensland.

<sup>1</sup> These three well-known species are extremely abundant over almost the whole coast, and are a distinct menace to pearl-oyster beds. During the period over which my work extended on the coast, more than five thousand of these were brought up in the dredge, while on the shallow reefs thousands may be seen daily at low tide. The colour patterns on all these species, but especially on *P. lincki*, are worthy of attention. The general tone is in most cases blue, but the following variations in the colour of the spines were observed—(1) central spines orange, the others creamy-white; (2) all the spines vermilion-red; (3) all the spines creamy-white. Another type had bright yellow as a groundwork, while the spines were orange-coloured.

These few observations demonstrate the futility of basing any specific character on coloration in brightly-coloured asteroids.

*Pentaceros* sp.

In the collection there are three small specimens which are undoubtedly immature, but which belong to the genus *Pentaceros*. After a careful comparison of the type specimens of the various species of this genus in the British Museum, we have come to the conclusion that they approach nearest to *P. nodulosus*, Perrier, but in view of the fact that they are young and immature we would refrain from definitely referring them to this species.

The following notes may, however, be useful in illustrating the chief points of similarity and contrast.

The present specimens differ from the British Museum specimens on which Perrier founded the species *P. nodulosus* (*Archiv. de Zool. Expér.*, v., 1876, p. 53) in the following respects:—

$R = 67$	$r = 24$	$R = 2.8 r$
$R = 59$	$r = 21$	$R = 2.8 r$
$R = 56$	$r = 21$	$R = 2.3 r$

Perrier gives  $R = 2\frac{1}{3} r$ .

Marginal plates:—Type specimen,	. 36 to 38.
Present specimens,	. 15 to 17.

Tubercles on the lophial line:—Type specimen,	. Ellipsoidal.
Present specimens,	. Dome-like.

In addition to this we may note that in our specimens there are tubercles, conical or dome-like, on the lateral and supero-marginal plates. On the lateral plates they become larger towards the disc, while, in contrast to this, on the supero-marginal plates they are more prominent towards the tip of the arm.

In larger specimens of *P. nodulosus* these lateral lines are not to be seen, and it is possible that those of the specimens before us would disappear with the growth of the individual. In want of evidence regarding the possibility of this, we think it more advisable not to identify our specimens with this species at present. In the living animal the tubercles are light yellow, and the rest of the dorsal surface is dark brown.

The position of the madreporite is the same as in the type specimen, but whereas in *P. nodulosus* it is lozenge-shaped, in the present forms it is triangular to heart-shaped.

The spines of the ambulacral groove also show some variation :—

In *P. nodulosus*—(1) inner series, . 7 to 9 spines on each plate.  
(2) outer series, . 3 larger spines.

In the present specimens—(1) inner series, . 5 spines on each plate.  
(2) outer series, . 2 larger spines.

If our view of the species be correct, the great differences which may obtain between immature and mature specimens are most noticeable.

*Locality*.—Station IX., Matemo Island, Ibo Bay.

#### *Pentaceros* sp.

Another small specimen from Tunghi Bay is too young for specific determination.  $R=32$ ;  $r=13.5$ . The disc is distinctly elevated in the manner of *P. lincki*. On each lophial line are three or four prominent conical tubercles, culminating in size in the topmost one on the central disc, which is 3 to 4 millimetres in height. The tubercles are closely granulated, and through the granulated surface projects the small sub-acute apex. On the last two or three distal infero- and supero-marginal plates there are small spinous tubercles.

This may be a young form of *P. gracilis*, a species in which we know the development of spines is very variable. On the other hand, however, it may be an immature stage of *P. lincki*, but any categorical statement would be ill-advised.

*Locality*.—Station I., Tunghi Bay.

#### *Culcita schmideliana* (Retz.).

This very variable species is represented in the collection by a single large dried specimen which has become slightly damaged by damp. Only the dorsal skeleton and fragments of the ventral surface remain; however, the ventral tessellated plates show well.

In life the aboral surface was dark brown with much lighter brown poriferous areas: the oral surface was purple, becoming paler towards the mouth; the sides of the ambulacral groove were yellow, and around the actinostome there were distinct dark blue areas.

Referring to this species from Ceylon, Professor Herdman (*Rep. on Ceylon Pearl Oys. Fish.*, vol. ii. p. 144) remarks that "this cushion-like starfish . . . shows on the aboral surface a bright orange-coloured pentagon closely

papillated, and with the ambulacral grooves running as narrow red lines out to the angles. On the aboral surface there are short red spines on the well-marked lobed areas, while the surface between has a fine fluffy or velvet-like appearance."

*Locality*.—Station IX., Matemo Island.

*Previously recorded from*—Red Sea; Dar-es-Salaam; Zanzibar; Mozambique; Madagascar; Mauritius; Ceylon; Andaman Is.; and Amboina.

*Calcita* sp.!

This large starfish, popularly known as the "leather bun," is almost universally distributed along the coast, though not in such abundance as *Pentaceros*. The following notes may show the protean nature of the colour schemes in this wonderful genus. It is difficult to say if one or more species are here represented, but the former is more probable. These varieties are, at any rate, discernible:—

A. With black tubercles and scattered soft poriferous areas.

Ground, yellow,	.	.	.	Areas, grey.
" blue,	.	.	.	" brown.
" bright yellow,	.	.	.	" greenish-brown.
" salmon-pink,	.	.	.	" yellow.
" light grey,	.	.	.	" dark grey.
" bright yellow,	.	.	.	" yellowish-brown.
" grey,	.	.	.	" dark brown.

B. With tubercles but no different coloured poriferous areas.

Tubercles black, with the general tone yellow, orange-yellow, brown, or pink.

C. With coloured poriferous areas but no tubercles.

Ground, yellow,	.	.	.	Areas, brown.
" blue,	.	.	.	" grey.
" salmon-pink,	.	.	.	" brown.

One specimen was entirely red.

These notes show the extraordinary variability in colour of the highly coloured Asteroids, a fact very often overlooked by the cabinet zoologist, but well known to every field naturalist. This is evidence how little, if any, reliance can be placed on colour as a specific character.

**Ophidiaster cylindricus (Lam.), M. and T.**

This is a typical coral-reef species, and is represented in the collection by several specimens of different ages from Montepes Bay. The following notes may prove interesting in a study of development:—

$R = 146$	$r = 14$
$R = 104$	$r = 11$
$R = 92$	$r = 9$
$R = 69$	$r = 8.5$

In life the colour schemes of this species are extremely striking, and are by far the most brilliant in the associated fauna. Many specimens are dark red all over; others are of a bright yellow, with dark red to vermillion blotches on the arms. They are somewhat slimy to the touch when alive. There is never more than one madreporic plate.

*Locality*.—Station X., Montepes Bay, between Kilalia Island and Sinkori Island.

*Previously recorded from*—Muscat (Brit. Mus.); Mauritius; Ceylon; Kondavi, Fiji Islands; Moluccas.

**Linckia diplax (M. and T.).**

This is apparently one of the commonest Asteroids on the coast. There are numerous specimens from three separate localities, viz., Tunghi Bay, Kero-Nyuni Bay, and from the reefs separating Das Rolas Is. from Matemo Is.

$R = 175$	$r = 11$	$R = 16 r.$
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The number of arms varies from four to six, and two madreporic plates occur on every individual except in one with six rays, which has three.

There are three comet individuals, in one of which  $R = 112$ ,  $r = 9$ ; in another  $R = 60$ ,  $r = 8$ ; while in the third  $R = 89$ , and  $r = 39$ .

In the largest specimens the small rays are thick in proportion to their length, and comparatively blunt. In the others they are almost normal in proportion.

In several individuals one or more arms have been truncated, and regeneration is in progress.

The two predominant general colours are brown and blue, with black dots. Many, however, are greenish blue on the aboral surface, and bear minute black dots, which give the whole the appearance of a branching coral. The oral surface is purplish-red.

*Localities*.—Station I., Tunghi Bay; Station IX., Matemo Is.; Station VI., Kero-Nyuni Bay.

*Previously recorded from*—Mozambique; Madagascar; Bourbon; Mauritius; Ceylon; Christmas Is.; New Caledonia; Fiji; and Friendly Islands.

*Linckia marmorata* (Michelin). (Figs. 1-4.)

The specimens which we have referred to this species were at first a little perplexing—in fact, from the original description and figures of *L. marmorata* it is well-nigh impossible to distinguish the species.

The type specimen was described by Michelin in 1844 in the *Revue Zoologique* as *Ophidiaster marmoratus*, thus:—

“O. minima; radiis quinis, cylindraceis, violaceis et luteolis; parte superiori longitudinaliter quinque costatis, transverse rugosis, subtilissime granulatis, ad interstitiis varie tribus poris ornatâ; parte inferiori granulosâ; canalibus clausis; marginibus papillois, duabus lineis parvulis tuberculis ornatis, tuberculo madreporiformi parvulo, rotundo, sulcato, violaceo.”

In 1845 Michelin again referred to it in the *Magazin de Zoologie*, p. 21, and also figured it (plate 10)—(“Essai d'une faune de l'île Maurice”).

In 1869, von Martens placed the species in the genus *Linckia* (*Claus von der Decken's Reise; Seesterne und Seeigel*, p. 130); while in 1875 Perrier (*Archiv. de Zool. Expér.*) revised the species but gave little new specific character to it. He notes, however, that the type specimen had the following measurements:— $R = 10$  mm.,  $r = 4$  mm. The species was therefore established on a very immature specimen.

In 1884, Bell resuscitated the species and made a valuable contribution to the specific diagnosis (*Zool. Coll. of H.M.S. "Alert,"* p. 125). On this description, and taking as a basis some specimens in the British Museum which Bell has referred to this species, we have identified these puzzling forms in the present collection.

The following notes are given as a contribution towards the study of this species, and should be taken in conjunction with Bell's valuable variation references.

The arms are five in number; they are subconical, being slightly flattened on the ventral surface.

The measurements of the different specimens in the present collection are:—

$R = 48$	$r = 9$
$R = 38$	$r = 7$
$R = 37$	$r = 7$
$R = 37$	$r = 7$
$R = 36$	$r = 7$
$R = 34$	$r = 6$
i.e., $R = 5\frac{1}{2}$ to $5\frac{2}{3}r$ .	

The following is a description of the largest specimen (Figs. 1-4). The plates are all arranged in definite rows; they are markedly convex, and the axis is transverse. The following series may be distinguished:—One mid-dorsal series; two sub-lateral series; one very broad sub-ventral series. Several of the plates appear as if composed of segregations of smaller dome-like plates.

The median row, or mid-dorsal series, terminates in a larger plate at the junction of the arm and disc. Between these five plates, which are arranged pentagonally, five others are disposed symmetrically, while in the centre of the disc there occurs a single plate of a size similar to the others. The arrangement of the tubercles on the surface of the disc is markedly symmetrical.

The sub-lateral rows on opposite sides of adjacent arms are continuous through the angle; this series does not extend to the tip of the arm, but is terminated abruptly by the union of two sub-parallel poriferous areas.

The plates of the sub-ventral series are more or less rectangular in shape; they are densely covered with coarse regular granulations which are interrupted by a furrow, running medianly to half-way from the ventral edge of the plate.

The poriferous areas lie in six longitudinal rows, three on each side of the arms; the average number of pores in each group is about fifteen; the areas are distinctly larger than the corresponding plates. On each side of an arm the upper sub-lateral series of plates does not extend to the tip; consequently the poriferous areas which are otherwise separated by these plates are confluent in this region. Occasionally these larger poriferous areas are united transversely by small and almost inconspicuous lines, bearing pores.

The madreporic is simple and distinct, and recalls the structure of the coral *Fungia*. It is larger than the plates of the dorsal surface, and lies in the angle formed by the dorsal row of plates and the upper sub-lateral row.

The ambulacral armature is bi-serial; the inner row consists of large and small alternate spines, four or six on each plate (five may occur); they are blunt, sub-triangular in shape, and interlock. The spines of the outer series are larger, more distant, vertical, conical, and occur in pairs or threes on each plate.

In both series there is a tendency towards an alternation in these numbers—*e.g.* (1) inner series, four and six on alternate plates;

(2) outer series, two and three on alternate plates:

but from about halfway from the mouth to the tip of the arm the number tends to diminish and the rows lose their regularity. Occasionally a single

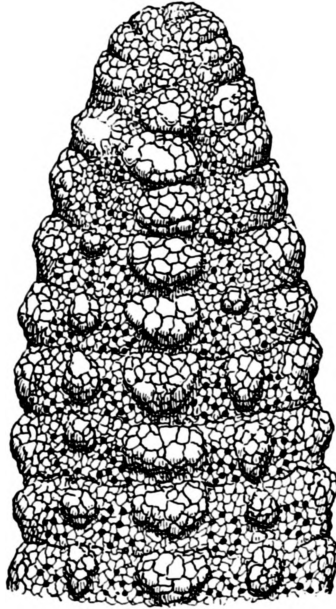


FIG. 1.

Tip of arm, dorsal view, showing the disposition of the various series of plates and poriferous areas.

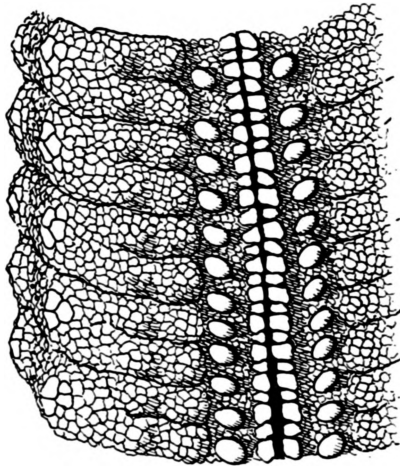


FIG. 2.

Portion of arm, ventral view, showing the structure and arrangement of the adambulacral armature.

*LINCKIA MARMORATA.*

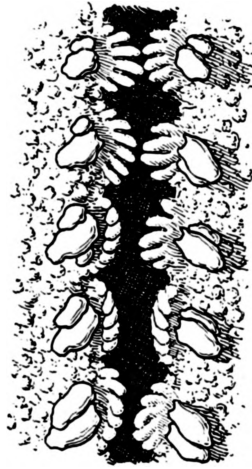


FIG. 3.

Portion of arm, ventral surface, showing the adambulacral armature.

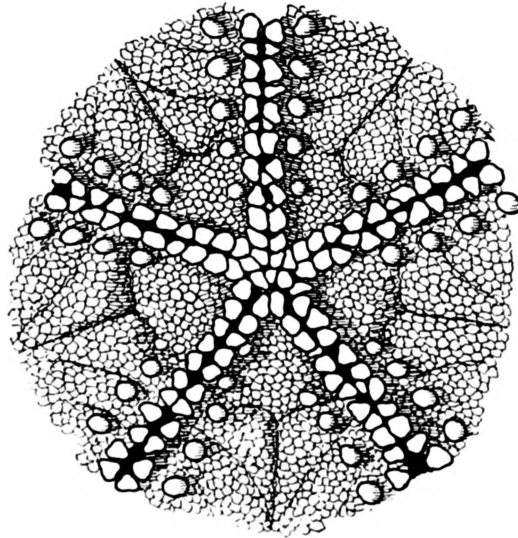


FIG. 4.  
Oral Region.

*LINCKIA MARMOREATA.*

additional spine may occur near the middle of a plate; this is more marked towards the distal end.

The colour fundamentally is brownish-grey, but the centre of the disc is usually purple. There are usually three or four transverse purple bands on each arm; these extend in some cases to the ambulacral groove.

*Locality*.—Type specimen: Station II., Wamizi Island. Five other specimens: Station I., Tunghi Bay.

***Nardoa variolata*, Gray.**

Two specimens from the reefs around Matemo Island represent this species. In the largest  $R=65$ ,  $r=11$ . Neither specimen is fully mature, and the number of plates on the side of each arm does not exceed 30 or 31, whereas in full-grown individuals 45 is not infrequent.

*Locality*.—Station IX., Matemo Island.

*Previously recorded from*—Red Sea; Zanzibar; Bourbon; Mauritius; Mozambique; Rodriguez; Ceylon; and Australia.

***Retaster cribrosus* (von Mart.).**

This species is very abundant on the coast, and specimens from four different localities are represented in the collection.

$$R=38, r=9; R=4\cdot2 r.$$

$$R=37, r=13; R=3 r.$$

Most of the specimens are fully grown, and in some of them the arms taper more than is usual in this species. In some individuals the paxillæ spinelets on the dorsal surface are not well developed, but even in young specimens they are never entirely absent.

The colour of the specimens is rather unusual. Most of them are black, with ashy-white ridges on the dorsal surface; sometimes these ridges are ruddy or even orange-coloured.

One specimen has only four arms, and these are arranged symmetrically.

*Localities*.—Station II., Maiyapa Bay (near Magi-mazizi); Station III., Mtundo Bay (between Wamizi Is. and Kifuki Is.); Station VI., Kero-Nyuni Bay; Station IX., Matemo Island.

*Previously recorded from*—Samoa and Philippines to Mergui; Amboina; Port Molle and Thursday Island, 4 fathoms (coral); Singapore; Ceylon; Mozambique; Dar-es-Salaam; and Zanzibar.

**On a New Species of *Cactogorgia*. By Jas. J. Simpson, M.A.,  
B.Sc., Carnegie Research Fellow, Natural History Department,  
University of Aberdeen. (With One Plate.)**

(MS. received January 24, 1910. Read January 24, 1910.)

AMONGST the unnamed *Alcyonaria* in the collection of the Royal Scottish Museum, Edinburgh, is a beautiful colony belonging to the genus *Cactogorgia*, which Mr Eagle Clarke has kindly handed me for identification and description.

In 1907 (*Trans. Roy. Soc. Edin.*) I established the genus *Cactogorgia* for several small colonies from the Indian Ocean, and referred these to three separate species, viz. *celosioides*, *alciformis*, and *expansa*. Thomson and M'Kinnon, in *Trans. Linn. Soc. (Zool.)*, 1909, have described another species from the Seychelles under the name of *Cactogorgia lampas*, and the present colony must also be referred to a new species. This we propose to name *Cactogorgia agariciformis*, n. sp., on account of its very definite mushroom-shape.

It is interesting to note that the inclusion of these two new species has not necessitated any change in the original generic diagnosis.

*Cactogorgia agariciformis*, n. sp.

This species is represented by a single specimen of a slightly orange-yellow colour—that is, after prolonged preservation in alcohol. It has been attached to rock, and the basal disc is overgrown by an encrusting sponge. The colony (fig. 1) is 7.5 cm. in height, and consists of two very distinct parts: (1) a lower, almost cylindrical, stalk, 4.8 cm. long, 7 mm. in diameter at the base and 12 mm. at the top; and (2) an upper, polyp-bearing, part, elevated in the centre, circular in outline and expanded horizontally, giving the whole colony a very distinct mushroom appearance. The breadth of the capitulum is 31 mm., and its maximum height 12 mm.

The whole colony is very stiff and rigid, owing to the densely interlaced, large, warty spindles, which are quite visible to the naked eye. These are arranged for the most part longitudinally, and give the translucent appearance which was characteristic of *C. celosioides* to the whole colony.

The stalk contains several large canals (fig. 2). These are supported by

extremely thick non-collapsible walls which are densely packed with large warty spicules. The canals branch near the capitulum, and connect with the polyps by means of small solenia.

The polyps are situated all over the capitulum, few in number, of a large size, and arising like the disc florets in the Compositæ (fig. 1). Each consists of a very distinct verucca, which is supported by large longitudinally arranged spindles. The apices of these project, and form strong protection to the retracted anthocodia. The oral openings of the verrucæ are about 5 mm. apart, but the bases overlap slightly.

The anthocodiæ are all retracted within the verrucæ. They are moderately large, and have a dense armature. They are about 2 mm. in height and 1 mm. in diameter. The anthocodial armature (fig. 3) consists of a "crown" and eight distinct "points." The "crown" consists of about twenty-two to twenty-eight rows of slightly curved spicules, which are placed circumferentially and interlock closely. Surmounting this there are eight triangular "points," each consisting of about four pairs of slightly bent spicules which are arranged loosely *en chevron*. There are usually a few small scattered spicules between the "points." When at rest the tentacles are infolded and overlap one another, and when expanded are about 1 mm. in length. They are conical in shape, and have a few simple pinnules. They contain small scale-like spicules arranged *en chevron* on their aboral surface.

The spicules vary in shape and character in the various parts of the colony. Those of the stalk are for the most part large spindles, some of which are almost scale-like (fig. 4). They are covered with large papillose, irregular warts. In the verrucæ they are predominantly spindles, either straight or variously curved (fig. 5). These are also covered with warts, but are not so rugose as those of the stalk.

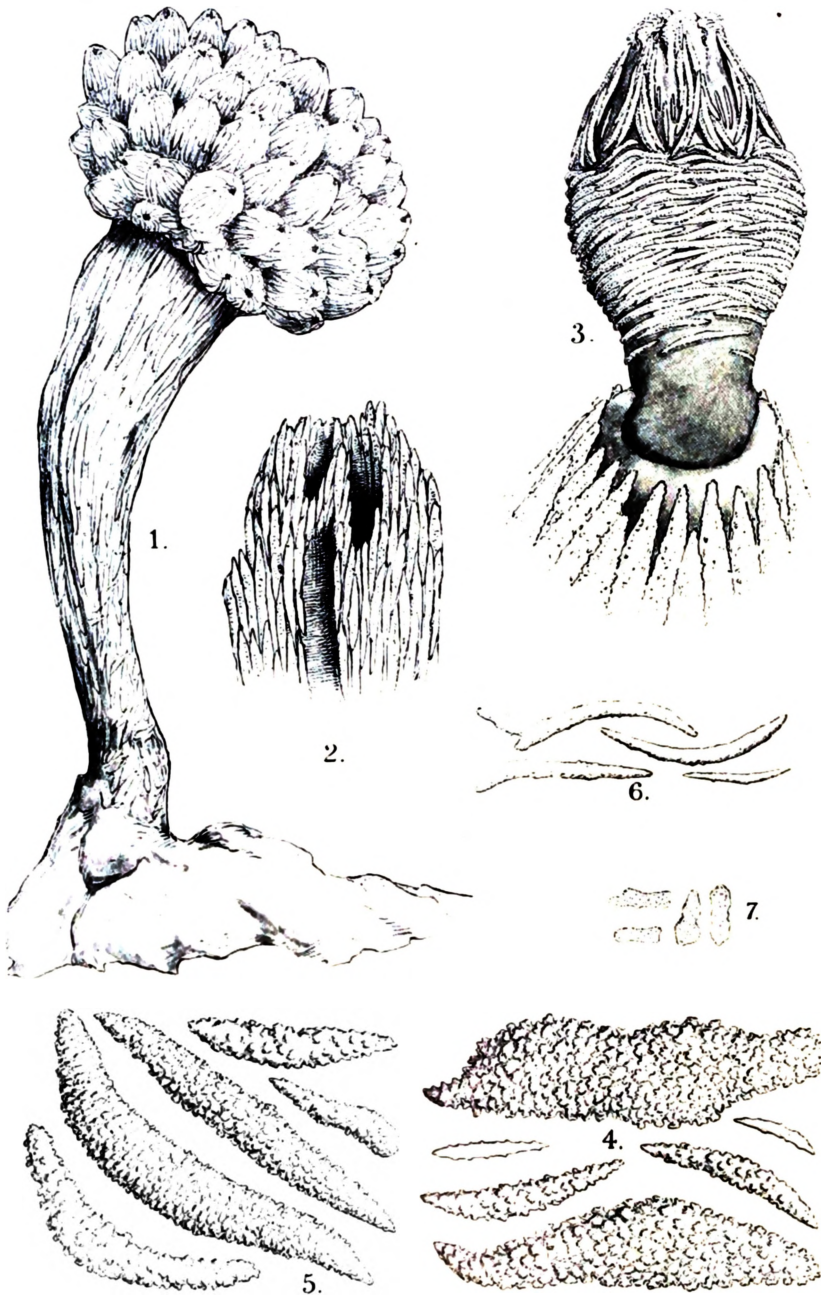
The spicules of the anthocodiæ are straight and curved spiny spindles. Some of these may bifurcate at one end (fig. 6).

On the aboral surface of the tentacles there are small scales, irregular in outline or with a slight constriction in the middle. The flattened surface of these is slightly papillose (fig. 7).

The following are some of the measurements of the chief types, length by breadth, in millimetres :—

- (a) Stalk,  $2.5 \times 0.4$ ;  $2.5 \times 0.36$ ;  $1.2 \times 0.2$ ;  $0.9 \times 0.2$ .
- (b) Verrucæ,  $2.8 \times 0.4$ ;  $2.5 \times 0.3$ ;  $1.25 \times 0.2$ .
- (c) Anthocodiæ,  $0.9 \times 0.1$ ;  $0.85 \times 0.07$ ;  $0.8 \times 0.045$ ;  $0.5 \times 0.05$ .
- (d) Tentacles,  $0.12 \times 0.04$ ;  $0.04 \times 0.02$ .





Mr J. J. SIMPSON.

*CACTOGORGIA AGARICIFORMIS*, n. sp.

The record of the locality of this specimen has been unfortunately lost. All the other species have been recorded from the Indian Ocean.

In some respects this species approaches *Cactogorgia expansa*, but it is easily distinguished by the characteristic shape of the colony and by the architecture of the anthocodial armature.

The following table gives a summary of the differences in the anthocodial armature for the different species of *Cactogorgia* :—

Species.	"Crown."	"Point."
<i>C. celosioides</i> , Simpson.	7-10 rows of curved spindles.	1 large pair, with occasionally 1 or 2 smaller ones between.
<i>C. expansa</i> , Simpson.	About 8 rows of curved spindles.	6-8 pairs arranged <i>en chevron</i> .
<i>C. alciformis</i> , Simpson.	10-14 rows of curved spindles.	10-15 spindles only <i>slightly en chevron</i> .
<i>C. lumps</i> , Thomson and M'Kinnon.	6 rows of horizontal spindles.	About 3 converging pairs of spindles, and between two "points" lies a single spindle.
<i>C. agariciformis</i> , n. sp.	22-28 rows of slightly curved spindles.	4 pairs of curved spindles <i>en chevron</i> , with a few scattered between the "points."

#### EXPLANATION OF PLATE.

- Fig. 1. Colony enlarged almost twice natural size.  
 Fig. 2. Stalk broken across to show the large main canals ( $\times 6$ ).  
 Fig. 3. Polyps enlarged to show anthocodial armature ( $\times 35$ ).  
 Fig. 4. Spicules from the stalk ( $\times 25$ ).  
 Fig. 5. Spicules of the verrucæ ( $\times 25$ ).  
 Fig. 6. Spicules of the anthocodiæ ( $\times 40$ ).  
 Fig. 7. Spicules from the aboral surface of the tentacles ( $\times 85$ ).

(Issued separately March 10, 1910.)



**X.—Note on a Peculiar Clutch of Blackbird's Eggs and some other Abnormalities.** By Professor J. Arthur Thomson, M.A.

(Read 28th February 1910. Received 28th February 1910.)

THAT the eggs of birds show considerable variability—in size, shape, and colouring—is, of course, very well known, but I thought it might be of use to record an interesting case of variation—especially in size—in a clutch of Blackbird's eggs. I owe the clutch and the data as to the order in which the eggs were laid to my friend Mr R. Hay Fenton, who not long ago very generously presented to the Natural History Museum of Aberdeen University his remarkably fine and almost complete collection of the eggs of British birds.

There are four eggs in this Blackbird's clutch, which have the following dimensions—

- (i.)  $38 \times 24$  mm.
- (ii.)  $33 \times 23$  mm.
- (iii.)  $28 \times 22.5$  mm.
- (iv.)  $27 \times 21$  mm.

The largest egg (i.) was laid first, but it did not develop; the next largest (ii.) followed and was fertile; the third (iii.) was near the normal size; the smallest egg (iv.) was laid last. The third and fourth were quite fresh when the clutch was taken.

In his great work on the eggs of the birds of Europe, Dresser notes that the eggs of the Blackbird vary from  $28 \times 21.33$  mm. to  $32 \times 22.35$  mm., and quotes as an average of 48 eggs,  $28 \times 21$  mm.; so that the interest of the clutch exhibited is that the first egg is far above the average, and that the abnormality goes on decreasing egg after egg. There is a progressive variation in a minus direction.

I do not wish to make too much of a little thing, but it is of interest to compare a case like this with others where we see at work the mysterious regulative tendency which is characteristic of living creatures. Thus Raymond Pearl recently described a case (*Journ. Exper. Zool.*, vi., 1909, pp. 339-351, 1 pl.) in which the first egg laid by a pullet was very abnormal in shape—elongated ovate pyriform. In the subsequent eggs laid there was a quite gradual change of shape, which was regulative in character, until finally the eggs were quite normal.

Numerous abnormalities in the eggs of the common fowl have been recorded, and the collection now shown illustrates not a few. It is an

object-lesson in variability. The most remarkable form which I have to show consists of a small oval giving origin to a twisted tube like the horn of a shorthorn sheep. Such occurrences have been in some measure cleared up by a recent daring experiment made by Pearl and Surface (*Science*, xxix., 1909, pp. 428-9). In order to determine the nature of the stimulus which induces the making of a shell, they performed an operation on a hen as a result of which the contents of the intestine were made to pass through the shell-secreting part of the oviduct. The interesting result was, that they got curious enshelled masses of various shapes, and they were led to the conclusion that the stimulus which excites the shell-making glands is mechanical rather than chemical in nature, and that the formation of the shell is brought about by a strictly local reflex, and is not immediately dependent upon the activity of other portions of the reproductive system.

It may be said that this was to a certain extent known before from a study of what are popularly known as "wind-eggs." These are not true ova, they contain no vitellus. They consist of a mass of albumen the stimulus of which has induced the making of an enveloping shell. It has also been shown that foreign bodies may ascend from the cloaca into the oviduct and become surrounded by a shell. Thus a species of *Distomum*, which frequently occurs in the *bursa Fabricii* opening into the cloaca, may pass up the oviduct and be included intact in the albumen of an egg.

In an interesting paper on abnormal eggs in fowls, J. Kunstler points out (*Mém. Soc. Sci. Bordeaux*, iii., 1903, pp. 65-72, 7 figs.) that a frequent cause is a lack of tone in the oviduct, the normal peristaltic movements being disturbed in consequence. Thus an egg may return on its path and become surrounded by a second shell, thus resulting in one form of the not unfamiliar *ovum in ovo*.

In a paper on "Ovum in Ovo," by F. H. Herrick (*American Naturalist*, xxxiii., 1899, pp. 409-414, 3 figs.), it is suggested that an abortive egg or egg-fragment may be enshelled and then included within the shell of another egg of larger size. In other cases, what is included has nothing of the nature of an egg about it, though it has been enshelled. Entirely different again are eggs with double or triple yolks, where we have to deal with a fusion of the albumen in two or more ova, which are treated in the oviduct as one egg and surrounded by a single shell. This process may be sometimes complicated by the inclusion of a third egg of normal size and already covered by a hard shell. So when we speak of an egg within an egg, we may mean one of three or four different things.

The problem of the factors which determine the shapes of the eggs of birds has been discussed in a very interesting paper by Prof. D'Arcy W.

Thompson (*Nature*, 4th June 1908, pp. 111-113). The egg, consisting of a slightly extensible membrane filled with an incompressible fluid is subject to external pressure from the radially contractile oviduct, and an equation for the shell can be worked out. It is pointed out that from the nature and direction of the usual peristaltic wave in the oviduct the pressure will be greatest somewhere behind the middle of the egg; in other words, the tube is converted for the time being into a more conical form, and the simple result follows that the anterior end of the egg becomes the broader and the posterior the narrower. One may recall how the peristaltic movements of the intestine in many animals, such as the rabbit, divide the faecal matter into spherical or oval masses.

The object of the present note is to record a case of variation with subsequent regulation, to show in a collection of hen's eggs how large the crop of variations is, and to note the suggestions that have been offered in interpretations of certain not uncommon freaks, such as a trumpet-shaped egg or an egg within an egg.

(Issued separately, 11th May 1910.)



XI.—Note on *Eunephthya glomerata*, Verrill, from the Færoe Channel.

By Professor J. Arthur Thomson, M.A.

(Read 28th March 1910. Received 28th March 1910.)

I HAVE previously recorded in the *Proceedings* of this Society the occurrence of two interesting Anthozoa from the Færoe Channel, *Primnoa reseda*, Linn., and *Antipathes larix*, Esper, and as it seems worth while continuing the list as specimens turn up, I wish now to add *Eunephthya glomerata*, Verrill. I obtained a single specimen from the collections of the "Goldseeker," and I am indebted to Prof. D'Arcy W. Thompson, C.B., for permission to make it the subject of this note.

The small colony rises to a height of about 22 mm. with a maximum breadth of 15 mm. A short trunk bears about three dozen polyps in ill-defined groups. There are so many spicules that the whole colony is stiff, and the surface has a glistening, frosted appearance—more or less white in colour. Most of the polyps are 3 to 4 mm. in height, and the upper part shows eight strongly-marked longitudinal ridges and intervening grooves. The ridges taper, bend inwards round the mouth, and are continued into the inturned tentacles. These are curved like a crozier, and their aboral surface is heavily armoured with spicules which cease near the tip. The spicules are clubs and spindles, some compact irregular bodies and a few cruciate forms. The clubs vary greatly in size and appearance, but most of them have enlarged heads, extremely rough, with stout blunt processes usually directed towards the apex. The following measurements were taken of length and breadth—the latter measured across the club,  $0.15 \times 0.06$ ;  $0.2 \times 0.04$ ;  $0.3 \times 0.1$  mm. The spindles have usually sparse, blunt tubercles. Two common sizes are— $0.4 \times 0.04$ ;  $0.8 \times 0.02$  mm.

The large and somewhat difficult genus *Eunephthya*, as re-defined by Kükenthal, includes more or less branched Nephthyid colonies, with thin canal walls not thickly filled with spicules, with polyps without Stützbündel, in groups or singly, retractile or non-retractile, but not divided into distinct calycine and retractile portions. The nearest genus is *Gersemia*, in which a portion of the polyp is retractile within a distinct calyx.

The genus *Eunephthya* is divided into two main divisions—(1) *Alcyoniiform*, with thickened contractile terminal branches, with completely retractile, elongated cylindrical polyps disposed singly; and (2) *Nephthyiform*, with unthickened, non-retractile terminal branches, with polyps grouped in bundles, club-shaped, and non-retractile.

It is evident that our specimen belongs to the Nephthyiform division or sub-genus of *Eunephthya*, and to the group which Kükenthal calls *Divaricatae glomeratae*, including *E. glomerata*, Verrill, *E. hyalina* (Danielssen), *E. racemosa*, Studer, and some doubtful species.

I have recorded this specimen for faunistic reasons—it is a characteristically boreal animal previously recorded from deep water of 500 to 600 fathoms in Northern Seas, e.g., off Franz-Joseph Land, Spitzbergen, Jan Meyen, and Greenland. It was dredged in the Færoe Channel, Station 18A, 18th June 1906, from a depth of 355 metres. But the specimen has also some systematic interest.

My specimen agrees with *Eunephthya glomerata* in all respects except that it shows more numerous *delicate* spindles, more irregularly headed clubs, and among its irregular spicules none that I should call double stars. By making several distinct preparations from different parts of the colony, I have convinced myself that the slight divergence in the spiculation is quite unimportant, and not greater than that separating some other recorded varieties of the species. I strongly suspect that many of the spicules described and figured as double stars are the broken off heads of very much knobbed clubs. In appearance, and in some of its spicules, my specimen very closely resembles *Eunephthya racemosa*, Studer, from Newfoundland, and may, I think, be taken as showing that the latter should be included in *E. glomerata*, Verrill.

Kükenthal has already united with *Eunephthya glomerata* quite a number of species—*Ammothoa luetkeni*, Marenzeller, *Nephthya polaris*, *Nephthya flavescens*, *Nephthya rosea*, *Drifa islandica*, and *Gersemiopsis arctica* (all due to Danielssen's exaggerated emphasis on minute differences). I think *E. racemosa*, Studer, should be added to the list. Moreover, in the detailed description and numerous figures that Danielssen has given of *Drifa hyalina* (which, as Kükenthal shows, is certainly a species of *Eunephthya*), I find no satisfactory reason for keeping even it apart.

Danielssen noted that *Nephthya flavescens*, *N. polaris*, and *N. rosea*, which are now identified with *Eunephthya glomerata*, are viviparous, and he gave a careful account of the embryos found free in the gullet. It is interesting to notice that the specimen under consideration, collected in the month of June, has numerous large free embryos in some of its polyps. Perhaps, as in some other cases, the viviparous habit is an adaptation to life in deep water.

(Issued separately, 11th May 1910.)

V.—*Note on Dendrobrachia fallax Brook, a Rare and Remarkable Antipatharian.*

By PROFESSOR J. ARTHUR THOMSON, M.A.

(Read February 16, 1910.)

IN a collection of Alcyonarians which I received for description from His Serene Highness the Prince of Monaco, there were four specimens of unusual appearance and puzzling character—with a spinose axis and pinnate tentacles—which are undoubtedly referable to a remarkable type of Antipatharian, which Brook described in 1889 under the name *Dendrobrachia fallax*. Although I have not much that is new to add to Brook's excellent description and figures, it may be of interest to record the re-observation of an extraordinary type, which seems to have remained unnoticed for more than twenty years. Very unfortunately, three of the specimens were dry, while the fourth, which was preserved in spirit, had only a few extremely brittle polyps.

What are the peculiarities of the type which give it a somewhat aloof position among Antipatharians?

1. The axis is without a central canal. In its younger parts it consists of about five longitudinal ridges or plates, standing out from a thin central stem and showing a distantly dentate margin. As growth goes on, there seems to be an increase in the number of outstanding ridges, and at the same time, by the deposition of successive concentric layers of horn, the deep troughs between the ridges are filled up, and an approximation to the ordinary type of Antipatharian axis is thus reached. There is great diversity in the size and shape of the spines in different parts of the colony. The colour of the axis varies from yellowish-brown to amber-brown. The basal portion, which was absent in Brook's two specimens, is well seen in two cases.

2. The polyps are even more remarkable than the axis. They arise laterally, often in sub-opposite pairs, but there may be a considerable interval, of two lengths or more, between two pairs. In short, they are much more distant than is usual in Antipatharians. Nor do they, in most cases, stand out at right angles, as Antipatharian polyps usually do; they are often appressed to the twig, or form an acute angle with it. The tentacles are retractile, which is also unusual, so that in some cases there is simply a circle of knobs around the prominent oral cone. Still more striking is the fact that they bear well-developed pinnules, six to seven pairs in the

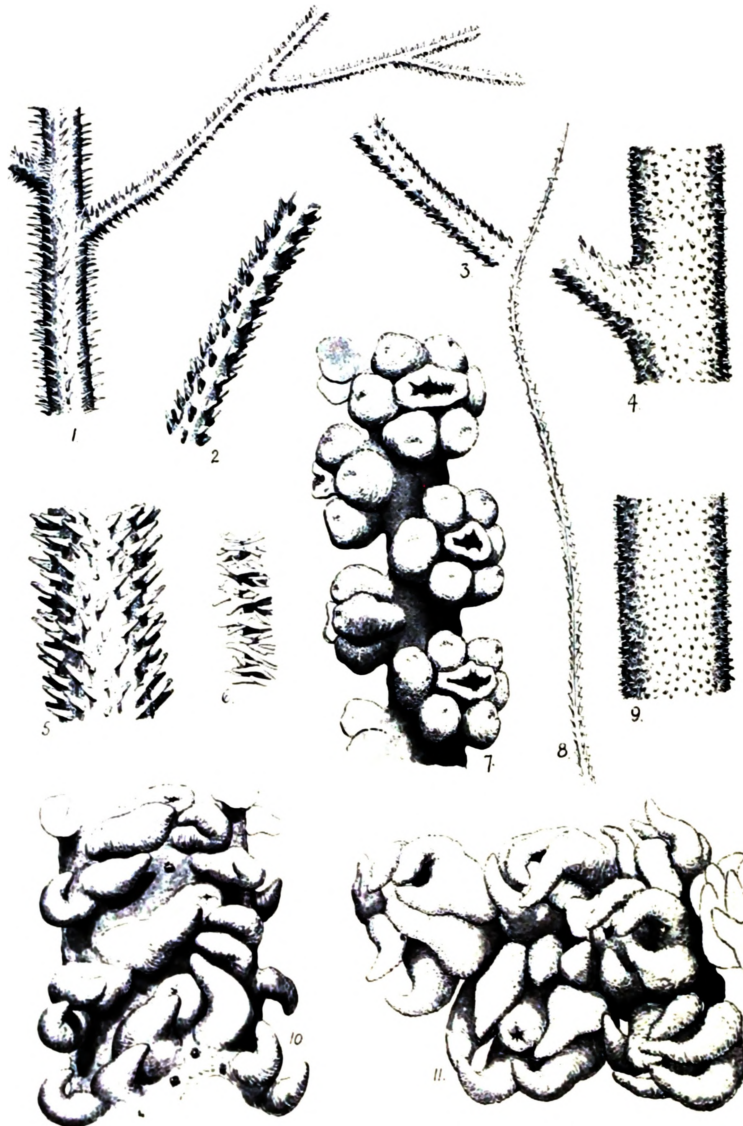
twelve polyps examined. It was impossible to cut the extremely brittle tissue, and the tentacles split very readily up the middle, but in four or five cases there seemed no doubt as to the presence of eight. Brook was not able to determine the number. In one case it seemed fairly certain that there were eight mesenteries.

The occurrence of eight pinnate tentacles at once suggests an Alcyonarian, and one was reminded that in many cases Alcyonid Alcyonarians grow over the naked axes of Gorgonids so thoroughly that a very deceptive appearance results. There is not, however, anything—such as uncovered tips on the twigs, or hummocking of the coenenchyma—to lead one to suppose that the specimen is not a unity. Moreover, there is no hint of Alcyonarian spicules, and the pinnules on the tentacles are much more irregular than in Alcyonarians. One would not indeed consider this possibility, were it not that some cases of the masking of extrinsic axes by Alcyonarians are almost incredibly deceptive, and were it not that the type in question is such a puzzling Antipatharian.

That Antipatharians have affinities with Zoantharians seems probable, and it is interesting to remember that the primitive type *Edwardsia* has only eight complete mesenteries, that a young *Halcampa* has eight tentacles, and that some sea-anemones, e.g. *Actinodendron*, have irregularly pinnate tentacles. There seems to be little doubt that *Dendrobrachia fallax* is a primitive Antipatharian, nearer than many to the Zoantharian stock. One would like to see more of it.

Brook's two specimens were dredged in 1876 from 425 fathoms off Ascension; those now exhibited were dredged in 1901 from 219 fathoms off the island of St. Vincent, in the Cap. Verde Islands.





INDIAN OCEAN ANTIPATHARIANS.

West, Newman imp.

(JOURN. R. MICR. Soc., 1910, pp. 273-281.)

VIII.—*Antipatharians from the Indian Ocean.*

By SOPHIA L. M. SUMMERS, M.A. B.Sc.  
(Natural History Department, University of Aberdeen.)

(Read March 16, 1910.)

(PLATE V.)

THE Antipatharians here reported on were collected for the most part at Ibo, in Portuguese East Africa, by Mr. Jas. Simpson, M.A. B.Sc., Carnegie Fellow, University of Aberdeen. A few were collected in the Mergui Archipelago by Mr. R. N. Rudmose-Brown, B.Sc., and Mr. Simpson.

The collection includes fourteen species, of which three are new. The list is as follows.

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EXPLANATION OF PLATE V.

- Fig. 1.—*Antipathes abies* Gray. Arrangement of spines, main axis.  
" 2.—*A. salicoides* sp. n. Arrangement of spines near the tip of the axis.  
" 3.—*Pteropathes simpsoni* sp. n. Arrangement of spines.  
" 4.—*Antipathes salicoides* sp. n. Arrangement of spines, main stem.  
" 5.—*Stichopathes bispinosa* nom. n. Arrangement of spines.  
" 6.—*Antipathes abies* Gray. Showing forked spines.  
" 7.—*A. salicoides* sp. n. Polyps on main branches.  
" 8.—*A. tristis* Duchassaing. Arrangement of spines.  
" 9.—*Cirripathes indica* sp. n. Arrangement of spines.  
" 10.—*Stichopathes bispinosa*. Polyps.  
" 11.—*S. echinulata*. Polyps.

## Family ANTIPATHIDÆ Verrill.

## Sub-family ANTIPATHINÆ Brook.

Section 1. **Indivisæ.**Genus *Cirripathes* Blainville.*Cirripathes indica* sp. n.*C. propinqua* Brook.*C. spiralis* Linn.Genus *Stichopathes* Brook.*Stichopathes diversa* (Brook) = *Cirripathes* (?) *diversa* Brook= (?) *S. alcocki* Cooper.*S. hispidosa* nom. n. = *Cirripathes* (?) *flagellum* Brook ; n.= *Stichopathes flagellum* Roule.*S. echinulata* Brook.*S. gracilis* Gray.Section 2. **Ramosæ.**Genus *Antipathes* Pallas.*Antipathes salicoides* sp. n.*A. furcata* Gray.*A. tristis* Duchassaing.*A. lentipinna* Brook.*A. gracilis* Gray.*A. abies* Brook.Genus *Pteropathes* Brook.*Pteropathes simpsoni* sp. n.*Cirripathes indica* sp. n. Plate V. fig. 9.See *Cirripathes* (?) Thomson and Simpson, Ceylon Pearl Oyster Report, 1905, Supplementary Report 30, p. 95, fig. 8.

A simple colony wound in a large circle, whose circumference is 77 cm. and diameter 18 cm. The polyps are badly preserved, but are distributed all round. In some parts they are crowded together. The axis is black, 2 mm. in diameter, with a canal of 0.5 mm.; it is covered with minute spines, distinctly papillose, all alike and equal. They are arranged in no definite order, and from twenty-four to thirty can be seen from one aspect. The specimen agrees with the specimen which Thomson and Simpson described but did not name.

*Locality*.—Portuguese East Africa. Previously recorded from Ceylon.

*Cirripathes propinqua* Brook.

See Brook, Report on the Antipatharia of the 'Challenger' Expedition, 1889.  
p. 82, pl. x. figs. 9-13; pl. xii. fig. 14; pl. xiv. fig. 7.

Of the several broken specimens one is 32.5 cm. in length, and is very stout and straight, difficult to bend or break. It is thickly covered with cœnenchyma, and the polyps are arranged all round the axis. They are not all of the same size, the largest being about 2 mm. in diameter. They stand out prominently, about 2 mm. high. The tentacles are long and tapering, and the mouth is prominent. The axis is thickly covered with spines and is 5 mm. in diameter; the central canal is only 1 mm. in diameter. The spines are short and thick, and are longer on one side of the stem than on the other. They stand out at right angles to the axis, but are not arranged in any definite order.

*Locality*.—Portuguese East Africa. Previously recorded from New Guinea.

*Cirripathes spiralis* Linn.

See Brook, Report on the Antipatharia of the 'Challenger' Expedition,  
p. 85, pl. xii. fig. 10.

Of the two specimens, one is spirally coiled, 33.3 cm. round the spiral, and 8.5 cm. high; the other is twisted irregularly, 33.4 cm. in length. On the spiral specimen there are only a few polyps left; the other has numerous polyps, but badly preserved. They are crowded together and are arranged all round the axis. They are circular, 2 mm. in diameter; the tentacles are long. The cœnenchyma is very thin. The axis, which is not very stout, is black in colour. Its diameter is 1 mm., while that of the central canal is 0.5 mm. The spines are short and conical, and are longer on the outer side of the spiral than on the inner. They are arranged in spirals and longitudinal rows, eleven of which can be seen from one aspect. The members of a row are about one length apart.

*Locality*.—Portuguese East Africa. Previously recorded from the Indian Ocean, Molucca, Norway, Mediterranean, Ceylon, Kurrachee, and the East Indies.

*Stichopathes diversa* (Brook).

See *Cirripathes* (?) *diversa* Brook, Report on the Antipatharia of the  
'Challenger' Expedition, p. 87, pl. 12, fig. 12.

A stout spiral, 15 cm. high. The polyps are arranged on the outer side, while the inner is left bare. They are straw-coloured in spirit, and are very flat, with long tentacles and prominent mouth. There are two types of spines, large ones with small ones between

them. The large ones are blunt and rough, and those on the outer side of the spiral are much longer than those on the inner. The small or secondary spines are short, sharp, and triangular. Cooper has described (1909) a new species, *Stichopathes alcocki*, but his description of it corresponds with Brook's description of *Cirripathes diversa*, e.g. in the arrangement and form of the spines. Brook could not decide whether his specimen belonged to *Cirripathes* or *Stichopathes*, as it was quite devoid of polyps. Cooper remarks on the large size of the central canal. It is probable that *S. alcocki* Cooper should be united with *S. diversa* (Brook). The canal is well seen in this specimen, the wall of the corallum being comparatively thin.

*Locality*.—Portuguese East Africa. Previously recorded from Galle, Ceylon.

*Stichopathes bispinosa* nom. n. Plate V. figs. 5, 10.

= *Cirripathes* (?) *flagellum* Brook non = *Stichopathes flagellum* Roule.  
See Brook, Report on the Antipatharia of the 'Challenger' Expedition,  
p. 87, pl. xii fig. 13.

The longer of the two specimens is 130 cm. in length, and is twisted into large spirals with a diameter of 21 cm. The axis is stout and sinuous, and tapers gradually. The diameter at the base is 7 mm. It is covered with thin coenenchyma, through which the spines project. The polyps are confined to one side of the stem, and are quite different from those of other species. They are flat, with a small mouth overlapped by two of the tentacles. A little to the side are two other tentacles, and pushed down the side of the axis is a third pair. At first sight one would believe the polyps to have eight tentacles. So closely are the mouths situated, that it is difficult to discover to which polyp the tentacles belong. The tentacles are short and thick. The spines are arranged in longitudinal rows, nine of which can be seen from one aspect. They are very large (about 0.5 mm.), and they gradually decrease until exactly opposite the longest spines are the shortest (about 0.1 mm.). There are secondary spines scattered between the rows. The spines are distinctly papillose at the tip. Members of a row are about a length apart. The central canal is very large, having a diameter of 1.5 mm. The arrangement of the spines and the general characters of the specimen correspond exactly with Brook's description of *Cirripathes* (?) *flagellum*. As Brook's specimen had no polyps, he could not decide whether it should be referred to *Stichopathes* or to *Cirripathes*.

*Locality*.—Portuguese East Africa. Previously recorded from Ceylon.

*Stichopathes echinulata* Brook. Plate V. fig. 11.

See Brook, Report on the Antipatharia of the 'Challenger' Expedition, p. 92, pl. xii. fig. 9.

Of several specimens, the longest is 95 cm. It is twisted in irregular spirals. The axis gradually tapers to a fine point. The diameter at the base is 1 mm., and of the central canal 0.5 mm. The polyps are large and crowded on one side of the axis. In some of the specimens they show a peculiar mode of growth, being bunched together at intervals in a sort of hummock. The longest diameter of the polyp is 3 mm. The mouth is raised on a prominence 1 mm. in height. The tentacles are long and thin. The spines are numerous, and are arranged in steep spirals. Of the vertical longitudinal rows of the spiral, nine can be seen from one aspect. In one part of the stem the spines are short, triangular, and much compressed; at another part they are much longer. Members of a row are about three lengths apart.

*Locality*.—Portuguese East Africa. Previously recorded from Mauritius.

*Stichopathes gracilis* Gray.

See Brook, Report on the Antipatharia of the 'Challenger' Expedition, p. 90, pl. xii. figs. 17-19.

Two fragments, one 26.5 cm., the other 8 cm. The larger specimen is somewhat spirally coiled. The axis is black and tapering. At the base it is 2 mm. in diameter, at the tip 1 mm. The polyps are on one side of the axis, and are large and circular (2 mm. in diameter); the tentacles are short and thick; the mouth is prominent. The spines vary very much in different portions of the axis. In slender portions of the stem the spines are arranged spirally and in longitudinal rows. They are triangular and compressed and stand at right angles to the axis. In thicker portions the arrangement is less regular. Most are simple and have a sharp apex, but a few are forked at the tip.

*Locality*.—Portuguese East Africa. Previously recorded from Fiji, Red Sea, Seychelles, Ceylon.

*Antipathes salicoides* sp. n. Plate V. figs. 2, 4, 7.

The whole colony is like a miniature weeping-willow. The main stem, which seems to be broken, is only 10.5 cm. high. It is 2 mm. in diameter at the base, and gives off long tapering branches from one side, the first of which reaches a length of 32.5 cm. Some of these branches remain undivided, while others give off long slender twigs. The whole specimen is densely

covered with polyps, which are arranged alternately on the branches. They are large and circular; the mouth is prominent; the tentacles are short and thick—the two transverse ones lying a little below the level of the others. The diameter of the largest polyp is about 2 mm. The spines on the main stem are crowded, and do not all point in one direction—an unusual feature. They are arranged neither in rows nor in spirals. On the branches the spines are short, sharp, and triangular. They are arranged in longitudinal rows, seven of which can be counted from one aspect. The members of a row are about one length apart.

*Locality*.—Portuguese East Africa.

*Antipathes furcata* Gray.

See *Antipathes* (?) *furcata* Brook, in Report on the Antipatharia of the 'Challenger' Expedition, p. 104, pl. xi. fig. 2.

The main stem is broken, and is only 5 cm. in length. It gives rise to a branch which reaches the length of 8 cm., and is then broken. It in turn gives rise to a branch 23 cm. in length. The axis of this branch tapers very markedly, and gives off delicate branches on all sides and in no definite order. These are mostly directed upwards. The polyps, which are badly preserved, are elongated in the direction of the longitudinal diameter of the axis, and are twice as long as they are broad. They are about 1 mm. in length. They lie close together, but are not crowded. The tentacles are short. The spines are short, triangular, and compressed, and are far apart. They are arranged in longitudinal rows, six of which can be seen from one aspect.

*Locality*.—Portuguese East Africa. Previously recorded from Madeira.

*Antipathes tristis* Duchassaing. Plate V. fig. 8.

See *Antipathella* (?) *tristis* Brook, Report on the Antipatharia of the 'Challenger' Expedition, p. 111.

A small delicate colony 5 cm. high. The stem is slender, and gives off delicate branches irregularly at right angles to the stem. Anastomoses occur, but are not frequent. The polyps are situated on one side of the axis. They are small, and have short digitiform tentacles. The polyps are about 1 mm. apart. The spines are sharp and triangular, and are arranged in irregular longitudinal rows, six of which can be seen from one aspect. Members of a row are about two lengths apart.

*Locality*.—Portuguese East Africa. Previously recorded from Guadeloupe, Santa Cruz, Montserrat, Martinique, St. Lucia, and Barbadoes.

*Antipathes lentipinna* Brook.

See *Antipathes* (?) *lentipinna* Brook, Report on the Antipatharia of the 'Challenger' Expedition, p. 103, pl. xi. fig. 19.

A shrub-like colony 28 cm. high, densely branched. The main axis is black and hard, 7 mm. in diameter. In the branches and pinnules the axis is light brown. The polyps are arranged on one side of the axis, and are large (2 mm. in diameter) and crowded together. Here and there small polyps are crowded in between the large ones. Branches are given off, usually from one side only. On the main stem the arrangement of spines is very irregular. The axis is flattened out, and the spines are scattered all over it, but on the branches they are arranged in regular spirals and longitudinal rows, five of which can be seen from one aspect. The spines are long and triangular, and are very close together.

*Locality*.—Portuguese East Africa. Previously recorded from the Red Sea.

*Antipathes gracilis* Gray.

See *Antipathella* (?) *gracilis* Brook, Report on the Antipatharia of the 'Challenger' Expedition, p. 113, pl. xi. fig. 8.

Two specimens, one 8.5 cm. in height, and the other a little over 9 cm. The latter is a delicate colony, with no regular mode of branching. The branches are thin and short, and are given off at right angles. Anastomoses are frequent, but the terminal fronds are free. The polyps are crowded together on one side of the axis. They are circular, 1.5 mm. in diameter. The tentacles are short and thick, one pair lying slightly below the level of the other two pairs. The spines are long and numerous, and are arranged in spirals and longitudinal rows, five of which can be seen from one aspect. Members of a row are from two to three lengths apart.

*Locality*.—Portuguese East Africa. Previously recorded from West Indies and Madeira.

*Antipathes abies* Gray. Plate V. figs. 1, 6.

See *Antipathes abies* Brook, Report on the Antipatharia of the 'Challenger' Expedition, p. 70, pl. xi. fig. 21.

The four specimens show a remarkable difference in the mode of growth. The first specimen, from Five Islands, consists of two fragments, much-branched and bearing many polyps. Some of the polyps are very well preserved, and show a prominent mouth raised

on a cone, and long tentacles. The polyps are arranged close together on one side of the stem, and are relatively large. The cœnenchyma is thin, and the spines can be seen projecting through it. The spines are very numerous. On the lower part of the stem they are sharp and needle-like, and stand out at right angles to the axis, but on the branches they are small and blunt, and lean towards the axis. The second specimen is 16 cm. in length. The mode of branching is the same as in the first case. The branches are given off all round. The main axis is thick. The polyps are situated on one side of the axis, and are crowded. They are 0.5 mm. in the longest diameter. The mouth is slit-like and prominent. The tentacles are much contracted, and are placed in three pairs round the mouth. The spines are exactly of the same type as those of the first specimen.

*Locality*.—Portuguese East Africa.

The third specimen branches in one plane and is fan-like. The main axis is thick and flattened out at the base, and gives off alternate branches. The polyps are similar to those of the second specimen, but are far apart, being separated on some parts of the axis by intervals of fully 0.5 mm. The spines are of the same type as in the previous specimens, but are not so long on the stem.

*Locality*.—Portuguese East Africa.

The fourth specimen is from Bentinck Island, Mergui. It is similar to the last specimen in being fan-like, but the branches are smaller and more delicate. It is 12.5 cm. high. The polyps are crowded together on the branches, and the largest have a diameter of 0.5 mm. The cœnenchyma is very thin. The spines agree with those of the other specimens, but the needle-like spines on the axis are very numerous. It seems that *Antipathes abies* is a very variable species.

*Pteropathes simpsoni* sp. n. Plate V. fig. 3.

A small colony, 10.5 cm. in length. The branching is irregular, and there seems to be no main axis. The whole specimen is clothed on one side with whitish polyps, which give it the appearance of being covered with a mould. These polyps are unfortunately so badly preserved that their structure cannot be made out, though in some parts long tentacles are seen. The spines, which are large and numerous, are triangular with a broad base. They are arranged in very steep spirals; seven or eight can be seen from one aspect. Towards the tip of the axis the spirals become irregular. The spines also form longitudinal vertical rows, the members of which are about a length apart, and in some places even less.

*Locality*.—Mergui Archipelago.

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*Alcyonarians from the Gulf of Cutch.* By Prof. J. ARTHUR THOMSON and Mr. GEORGE CRANE, B.Sc., University of Aberdeen. (Preliminary Note.)

IN the course of an investigation of the shallow-water fauna of part of the Gulf of Cutch, Mr. James Hornell made a small collection of Alcyonarians which presents some features of interest. The precise district was the coast of Okhamandal, which forms the N.W. extremity of the Kattiawar Peninsula, and Mr. Hornell has called our attention to the fact that specimens of *Dendronephthya* (better known as *Spongodes*), of *Lophogorgia*, &c. could be collected at low tide.

The collection includes eight species, one of which—*Astromuricea stellifera*—is new. There is also a new variety of a remarkable species of *Echinomuricea* previously found in the Indian Ocean.

The position of the various species may be indicated as follows :—

Order ALCYONACEA.

Family ALCYONIDÆ . . . (1) *Sclerophytum polydactylum* (Ehrenberg).

Family NEPHTHYIDÆ . . (2) *Dendronephthya* (*Spongodes*) *dendrophyta* (Wright and Studer).  
(3) *Dendronephthya* (*Spongodes*) *breziramia* (Burckhardt).

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Order AXIFERA.

- Family MURICEIDÆ .... (4) *Astromuricea stellifera*, sp. n.  
(5) *Echinomuricea uliginosa*, Thomson  
and Simpson, var. *tenerior*, nov.  
Family GORGONIDÆ .... (6) *Lophogorgia lutkeni*, Wright and  
Studer.  
(7) *Juncella juncea*, Pallas.

Order STELECHOTOKEA, Section PENNATULACEA.

- Family VIRGULARIDÆ .. (8) *Virgularia rumphii*, K  lliker.

(1) *Sclerophytum polydactylum* (Ehrenberg) is a well-known widespread species, previously reported from the Red Sea, Maldives, Gulf of Manaar, China Sea, Zanzibar, British New Guinea. It is characterized by the absence of siphonozooids, the small size of the autozooids, and the tough fleshy texture. The specimens from the Gulf of Cutch were large, the maximum dimensions being 5 cm. in height by 14 in length and 8 in breadth.

(2) *Dendronephthya* (*Spongodes*) *dendrophyta* (Wright and Studer), a species of the flattened umbellate type in K  kenthal's *dendrophyta* group, previously recorded from Philipines and China Sea. It is represented by loosely branched and close-set types of polyparium, as figured by Wright and Studer and by K  kenthal respectively; the anthocod  e show the characteristic eight double rows of curved spicules, 4 or 5 in each row; a trivial feature, noted by Wright and Studer, namely the occurrence of numerous superficial x-shaped spicules on the branches, is very marked. The specimens were collected in the month of December, and they show abundant reproductive bodies—probably sperm-sacs—up to 0.25 mm. in diameter, attached to the mesenteric bands far below the polyp-stalks. Some specimens show a few small polyp-bearing twigs on the top of the stalk below the foliate branches.

(3) *Dendronephthya* (*Spongodes*) *brevirama* (Burckhardt), a species of the flattened umbellate type in K  kenthal's *florida* group, previously recorded from China Sea and Torres Strait. A peculiarly fine specimen has a polyparium 12.5 cm. in height, with diameters of 10.5 cm. and 5 cm., with a very short stalk 1 cm. in height, and root-like attachments of about 6 cm. The anthocod  e show the characteristic eight double rows of spindles in chevron, with 5–7 in each row,

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the uppermost projecting slightly. A feature of some interest on several specimens is the occurrence of a number of small twigs on the short stem portion almost down to the level of the stolons, each twig bearing two or three polyps.

(4) *Astromuricea stellifera*, sp. n.—A reddish, fan-like, flexible colony (14 cm. in height by 28 cm. in breadth in maximum dimensions) with very abundant anastomosis. The axis is dark glossy brown and almost smooth. The cœnenchyma is very rough. The verrucæ are crowded on all sides of the axis; they are cylindrical and their apex is fringed by about a dozen projecting spicules. The anthocodæ are completely retractile within the verrucæ; there is a low, almost horizontal, tentacular operculum; two colourless converging spindles lie on the aboral surface of each tentacle, and there is a single or double ring at the base of the tentacles; otherwise there seem to be no spicules in the polyps. The spicules of the cœnenchyma are (1) irregular warty stars and toothed plates, (2) stout spindles with tuberculate warts, and (3) small irregular bodies—all of a rose-red colour. This species differs from the other members of the genus in many details, e. g. in the absence of long needle-like processes on the spicules fringing the mouth of the verruca.

*Localities.* Low water at Kiu Okha, and dredged off S.W. coast of Beyt Island.

(5) *Echinomuricea uliginosa*, Thomson and Simpson (1909), var. *tenerior*, nov.—The 'Investigator' collection of littoral Indian Ocean Alcyonarians includes a new species of *Echinomuricea* (*E. uliginosa*) which is described in detail by Thomson and Simpson in a memoir just about to be published. A variety of this species occurs in Mr. Hornell's collection. The diagnosis of the species is as follows:—A pinkish-red colony branched in one plane; the cœnenchyma is thick and very rugose, with spicules projecting in all directions; the verrucæ are thickly disposed, covering most of the surface; their walls bristle with the long smooth spines of projecting spicules; there is an elevated conical operculum composed of two bent spindles which touch for over three-quarters of their length, but diverge near the collaret, the interspace being almost completely filled by a short, curved, transversely disposed spindle; the horny axis is brown, cylindrical, and chambered, firm and flexible below, soft and collapsible above; the spicules include a variety of forms: (a) some showing a projecting smooth spine with branching warty arms

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at the base; (b) spindles covered with irregular warts; (c) spindles bearing in addition to warts a number of smooth projecting spines on one side; (d) irregular forms with warty branches on one side and smooth spines on the other; (e) bifurcate spindles; (f) irregular plates with warty branches; and (g) smooth spindles in the anthocodæ.

*Locality.* Laccadives (Kalpeni Bank) and Arakan coast, 13 fath.

The specimen from Cutch differs from the type in the following particulars:—It is unbranched (65 mm. in height, with a diameter of 3 mm.); it is more delicate in appearance and lighter in colour; the large pointed spicules surrounding the mouth of the verruca are pink to white, instead of deep red; the ground-colour of the cœnenchyma is white, instead of red or pink; the spicules are more delicate and bear longer spines; the superficial spicules of the cœnenchyma are white spindles with prominent rough warts, and reaching dimensions of  $0.61 \times 0.19$  mm., while the corresponding spicules in the type are thick red spindles with short close-set warts, and of larger size, viz.  $0.91 \times 0.23$  mm.

*Locality.* Off Dwarka, 16 fath.

(6) *Lophogorgia lutkeni*, Wright and Studer.—The representatives of this species are much larger and more copiously branched than those described in the 'Challenger' Report; the largest specimen reaches a height of 45 cm. and the main stem has a diameter of about 7 mm. The verrucæ show eight triangular marginal lobes bent over the retracted tentacles, and it is of some interest to note that while the verrucæ of some branches stand out to a height of 1 mm., the openings on other branches are flush with the general surface of the cœnenchyma.

*Locality.* Off Beyt Island, 3–4 fath.

(7) *Juncella juncea* (Pallas).—Unbranched and slightly branched colonies, yellowish white (with a touch of red) to buff in colour, with very crowded verrucæ without definite arrangement. The spicules are clubs and double stars, intermediate forms between clubs and double stars, and a few single stars. We have referred the specimens to *J. juncea* rather than to *J. gemmacea* because the former is the older species. Prof. Hickson has suggested that *J. juncea* and *J. gemmacea* should be united in one rather variable species, and a study of various representatives of *Juncella* has led us to the same

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conclusion. We think that *J. gemmacea* should be merged in *J. juncea*.

*Locality.* S.W. of Beyt Island.

(8) *Virgularia rumphii*, K  lliker.—We have referred two specimens to this species, although they differ in some obvious features, which appear to us, however, to have only quantitative importance. They agree with *V. rumphii* in having close-set pinnules with crowded polyps and with peculiar interlocking on the metarachidial surface, in having very numerous undeveloped pinnules (96–120 on each side), and in many other respects. They differ in having 55–70 polyps on a pinnule instead of 40–44, in showing no distinct siphonozoids (probably because of imperfect fixing), in having a more slender axis, and so on, but they are much nearer to *V. rumphii* than to any other species. In their very numerous polyps they suggest *V. multicalycina*, Thomson and Henderson, but the calices of the latter are exceedingly well defined, whereas they are indistinct in those from Cutch.



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[From the PROCEEDINGS OF THE ZOOLOGICAL SOCIETY OF LONDON,  
1910.]

[Published October 1910.]

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The Marine Fauna of the Mergui Archipelago, Lower Burma, collected by Jas. J. Simpson, M.A., B.Sc., and R. N. Rudmose-Brown, D.Sc., University of Aberdeen, February to May 1907.—The HYDROIDS. By JAMES RITCHIE, M.A., B.Sc., Natural History Department, The Royal Scottish Museum \*.

(Plates LXXVI. & LXXVII.†, and Text-fig. 79.)

The Hydroids were represented in the collections brought together in the Mergui Archipelago by Dr. John Anderson in 1882, and described in the Journal of the Linnean Society for 1889, by a meagre total of six species, two of which were regarded by Hincks as new. The reasonable anticipation that the careful collecting of Dr. Brown and Mr. Simpson would add many species to the Hydroid fauna of this region of the Indian Ocean has been amply fulfilled; for the present collection, confined to a littoral area, contains representatives of thirty species, only three of which (*Campanularia raridentata* and *Idia pristis*, both widely distributed species, and *Aglaophenia crispata*, a synonym of *Lytocarpus penarius*, *vide* Billard, 1909, p. 329) were included in Hincks's list.

As only two of the species, being described as new to science, must be regarded as peculiar to the Archipelago, the collection is well fitted to show the relationship which the Hydroid fauna bears to that of neighbouring seas. Leaving out of account an undetermined species of *Plumularia*, nineteen of the Mergui species have already been recorded from the Indian Ocean, the majority of these occurring off Madagascar and the eastern shores of Africa. The remaining ten species, indicated by

\* Communicated by R. KIRKPATRICK, F.Z.S.

† For explanation of the Plates see p. 825.

asterisks in the following list, have thus been added to the fauna of the Indian Ocean. As to the wider relationships:—Three species are peculiar to the Indian Ocean (*Corydendrium sessile*, *Hebella crateroides*, *Calycella oligista*), leaving twenty-six to be accounted for. Of these, twelve are so widely distributed that their occurrence, emphasizing the normal nature of the fauna, can give no indication of special affinity: three being found in the Atlantic and North Pacific Oceans and in Australasian seas (*Opercularella lacerta*, *Plumularia setacea*, *Antenella secundaria*); two in the Atlantic and North Pacific Oceans (*Perigonimus repens*, *Campanularia raridentata*); and seven in the Atlantic Ocean and in Malay-Australian seas (*Pennaria disticha*, *Halecium tenellum*, *Campanularia corrugata*, *Hebella calcarata*, *Sertularella polyzonias*, *Idia pristis*, *Diphasia digitalis*). Of the remaining fourteen, four have been found only in the Atlantic Ocean (*Eudendrium attenuatum*, *Cuspidella costata*, *Lafoëa serrata*, *Lafoëa venusta*), seven in the Malay-Australian area (*Eudendrium generalis*, *Cladocoryme haddoni*, *Halecium simplex*, *Thyroscyphus ritiensis*, *Sertularella cylindrica*, *Sertularella quadridens*, *Sertularia turbinata*), one in the North Pacific Ocean (*Thyroscyphus regularis*), and two in both the last-named areas (*Lytocarpus pennarius* and *L. phæniceus*).

The closer relationship is obviously with the fauna of the Pacific Ocean (represented by ten distinctive species), and in particular with the Malay-Australian portion of that ocean (represented by seven species). The significance of the apparent Atlantic affinity is minimised when it is understood that of the four species common to it and the Mergui Archipelago, one (*Eudendrium attenuatum*) is identified with much doubt, while the remaining three are very minute epizoid species, the presence of which in other regions may conceivably have been overlooked.

It is remarkable that of the thirty species recorded, seventeen were found climbing upon larger Hydroids and one upon a Polyzoon, the majority being minute, habitual epizoa, belonging in the main to the families Halecidae, Campanularidae, Campanulinidae, and Lafoëidae. The examination of this collection, and of others, leaves with me the distinct impression that the epizoid Hydroids are not distributed indiscriminately upon all types of Hydroid host. Thus, in general, the members of the family Plumularidae remain comparatively free from extraneous growths—a fact to be correlated, perhaps, with their possession of nematophores; while colonies, belonging especially to the family Sertularidae, are occasionally so overgrown that the structures of the host are much obscured. Even distinct preferences for certain species may be observed. Taking, for each epizoid species in this collection, the total numbers of stations at which it was found, and adding those numbers for all the epizoid species, we find that epizoid species were found at a sum total of forty-five stations. At thirty-two of these *Idia pristis* was either the only host, or one of the hosts where more than one species

was infested; *Thyroscyphus vitiensis* at nine; *Sertularella quadridens* at four; *Corydendrium sessile*, *Eudendrium attenuatum*, *Lytocarpus phœniceus* each at two; and *Diphasia digitalis* and *Plumularia setacea* each at one. This result bears out the impression gained from handling the collection, that *Idia pristis* is remarkably subject to infestation by extraneous Hydroid colonies. Frequently its hydrothecæ were all but obscured by the attendant growths of Hydroids and Polyzoa, and this although the state of the hydranths and of the cœnosarc generally, indicated that the host colony was in a perfectly healthy condition.

The occurrence, in *Lafoëa venusta* (?), of what appears to be a step towards a more intimate symbiosis; of a canaliculated cœnosarc in the stem and branches of *Sertularella quadridens*; of the hitherto undescribed gonosomes of *Halecium simplex* and *Thyroscyphus regularis*, are worthy of notice.

Finally, I would express my thanks to Dr. R. N. Rudmose-Brown and Mr. J. J. Simpson for entrusting this collection to me for examination.

#### *List of Species.*

#### I. Gymnoblastea.

##### Family CLAVIDÆ.

\**Corydendrium sessile*, sp. n., p. 802.

##### Family BOUGAINVILLIDÆ.

\**Perigonimus repens* Wright, p. 804.

##### Family EUDENDRIDÆ.

\**Eudendrium attenuatum* Allman (?), p. 804.

" *generalis* Lendenfeld, p. 805.

##### Family CORYNIDÆ.

*Cladocoryne haddoni* Kirkpatrick, p. 805.

##### Family PENNARIDÆ.

*Pennaria disticha* Goldfuss, var. *australis* Bale, p. 806.

#### II. Calyptoblastea.

##### Family HALECIDÆ.

\**Halecium simplex* Pictet, p. 807.

" *tenellum* Hincks (?), p. 808.

##### Family CAMPANULARIDÆ.

*Campanularia corrugata* Thornely, p. 809.

" *raridentata* Alder, p. 809.

*Hebella calcarata* A. Agassiz, p. 810.

" *crateroides* Ritchie, p. 810.

*Thyroscyphus regularis* Jäderholm, p. 811.

" *vitiensis* Marktanner, p. 812.

## Family CAMPANULINIDÆ.

- \* *Opercularella lacerta* Johnston, p. 812.
- \* *Calycella oligista*, sp. n., p. 813.
- Cuspidella costata*, Hincks, p. 814.

## Family LAFOEIDÆ.

- Lafoëa serrata* Clarke, p. 815.
- \* „ *venusta* Allman (?), p. 815.

## Family SERTULARIDÆ.

- \* *Sertularella cylindrica* Bale, var. *pusilla*, n., p. 817.
- „ *polyzonias* L., var. *cornuta* Ritchie (?), p. 818.
- \* „ *quadridens* Bale, p. 818.
- Idia pristis* Lamouroux, p. 820.
- Diphasia digitalis* Busk, p. 821.
- Sertularia turbinata* Lamouroux, p. 821.

## Family PLUMULARIDÆ.

- Plumularia setacea* Linn. (?), p. 822.
- „ sp. indet., p. 822.
- Antenella secundaria* Gmelin, p. 822.
- Lytocarpus pennarius* Linn., p. 822.
- „ *phœniceus* Busk, p. 823.

\* indicates a species recorded for the first time from the Indian Ocean.

## SYSTEMATIC DISCUSSION.

## I. GYMNOBLASTEÆ.

## Family CLAVIDÆ.

*CORYDENDRIUM SESSILE*, sp. n. (Plate LXXVI. figs. 1 & 2.)

**TROPHOSOME.**—Colony small, the largest of the three collected being only 37 mm. in height. The stem is strongly fascicled, 1.5 mm. thick towards the base, and straight. It may divide into main branches, which are beset by numerous smaller, almost equal branchlets, about 1 mm. in length. These spring from two opposite sides, and lie roughly in one plane. The branchlets on any one side are almost equidistant from each other, but their positions bear no regular relation to those of the opposing series. They taper very slightly towards the base, but there is no trace of ringing nor of wrinkling.

The majority of the hydranths spring from tubes on the anterior surface of the branchlets, although a few are also scattered on the main branches. The hydranth tubes do not become free from the common fascicle, except rarely and for an extremely short distance; nor are special hydrophore-like portions developed. Thus the hydranth projects simply from the open mouth of a tube, the adcauline wall of which is adnate. The hydranth tubes

are arranged in two series, the polyps of one series alternating with those of the other. The aperture faces outwards and upwards, is slightly elliptical in shape, and has an even margin, indicating the boundary between the thicker perisarc and the place where the chitinous coat becomes so thin and delicate that it follows the movements of the polyp. The perisarc throughout is covered by a thin coating of extraneous material—diatoms, sand-grains, fragments of sponge-spicules, and such like.

The hydranths are much contracted, and in this state exhibit a pyriform body with well-developed hypostome. The tentacles appear to number about forty.

Gonosome unobserved.

Colour, in alcohol, grey.

Dimensions:—

Diameter of branchlets immediately above origin	0.31–0.38 mm.
"    hydranth tube .....	0.25–0.31 mm.
Hydranth, length .....	0.52–0.98 mm.
"    diameter .....	0.21–0.42 mm.
Nematocysts on tentacles, length .....	5 $\mu$ .
"    "    breadth .....	3 $\mu$ .

*Locality.* Three small colonies, with hydrorhiza embedded in a sponge, were found at St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand.

So little is known of the variation liable to occur in the individual species of this genus, that it is difficult to fix on definite specific characters. In this case, I have relied mainly on the structure of the tubes from which the hydranths project. In the majority of the species of *Corydendrium* so far described these are free for a considerable distance below the hydranth; but here the tubes are adnate up to the end. This gives to the branches a dumpy appearance, unlike the lax growth of other species. In this respect it approaches most closely *C. corrugatum* Nutting (1905, p. 941), which is to be distinguished, however, by its distinct "hydrophore-like structures," which are "usually distinctly corrugated with deep irregular annulations"; by the presence of a well marked annular constriction near the origin of the branches; and by the large size (5 inches) of the colonies.

The species, *Soleniopsis dendriformis*, described by me in 1907 (1907, p. 494) as representing a new genus, under the erroneous supposition that *Corydendrium* gave rise to gonophores with free medusæ—I had been unable to refer to the magnificent description of Weismann (1883),—obviously belongs to the genus *Corydendrium*, as Dr. Stechow has recently pointed out (1909, p. 9).

*Corydendrium dendriformis* differs from *C. parasiticum* in possessing thick, definite stems, with branchlets arranged in pseudo-pinnate fashion, and in having the free portion of the tubes from which the hydranths project much shorter than those of *C. parasiticum*.

## Family BOUGAINVILLIDÆ.

## PERIGONINUS REPENS Wright, 1858.

Rare examples of an epizoic species occur, which cannot be specifically distinguished from British specimens of *P. repens*, the simple lax habit of which they exactly assume. There are differences between the dimensions of the Mergui and of British examples; for while the former are smaller in height and in the proportions of their hydranths and hydrocaulus, in respect of the nematocysts in the tentacles the order is reversed. The comparative table which follows shows at a glance the size-relations of the two forms. About twelve tentacles crown each hydranth.

No trace of gonosome was observed.

Dimensions:—	Mergui specimen.	Typical Scottish example*.
Height of colony .....	3 mm.	6 mm.
Diameter of hydrocaulus .....	0.04 mm.	0.07 mm.
Hydranth, length .....	0.17–0.24 mm.	0.24–0.34 mm.
„ greatest breadth .....	0.08–0.13 mm.	0.14–0.15 mm.
Nematocysts of tentacles, length	5.5 $\mu$ .	4.5 $\mu$ .
„ „ breadth	3 $\mu$ .	2.2 $\mu$ .

*Locality.* Rare colonies epizoic on *Corydendrium sessile*, from St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand.

The present record adds *P. repens* to the fauna of the Indian Ocean. It has already been noted from the eastern and western sides of the North, and the western side of the South Atlantic Ocean, from the Mediterranean Sea, and from the eastern and western (Japan: Stechow, 1909, p. 25) sides of the Pacific Ocean.

## Family EUDENDRIDÆ.

## EUDENDRIUM ATTENUATUM Allman (?), 1877.

Many poor colonies, lacking any trace of hydranth or gonosome, I refer, with uncertainty, to this species, on account of resemblance in the skeleton. The Mergui specimens attain a somewhat greater length (3 inches) than the original examples; but the delicate, very slender, non-fascicled stems, with their few branches, and their short hydranth-bearing ramules lying in one plane and set alternately at regular intervals of about 1 mm., are very similar in both cases. Three or four rather irregular annulations mark the base of each ramule, and occasionally a few odd rings occur irregularly on the ramules and on the stem itself. The regular and close alternation of the hydranth-bearing ramules seems the most evident character of an indefinite species, though a somewhat similar arrangement is observed in *E. maldive* Borradale (1905, p. 838).

\* Slide of specimen from Loch Carron, 60 fathoms, in my collection.

## Dimensions:—

Stem, diameter ..... 0.20-0.24 mm.

Hydranth-bearing ramules, diameter . 0.11-0.16 mm.

*Localities.* Many colonies from St. 22, Hastings Harbour, 3 to 20 fathoms and shore, rock and sand; and a few poor colonies, paler in colour, from each of Stations 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; and 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells, and rock.

Recorded originally by Allman from S.S.W. of Tortugas, at a depth of 60 fathoms, this doubtful species forms an addition to the fauna of Indian seas.

*EUDENDRIUM GENERALIS* Lendenfeld, 1885.

The colonies belonging to this species are mature, but are only about 1 cm. in height. They bear well-developed female gonophores, oval in shape, which spring in a whorl of four or five from the base of a hydranth, as in Kirkpatrick's description and figures (1890, p. 607, pl. xv. fig. 2).

The trophosome of this species is hard to distinguish from that of *E. capillare*. The more slender character of the branches of the latter, relied on in part by Kirkpatrick, is of little value, since a considerable amount of variation occurs in both species. On the other hand, the branching of *E. capillare* is more profuse, and irregular; also in the Australian species there is, in the smaller branches, distinct alternation, while the whole colony appears more rigid than the lax growths of *E. capillare*.

## Dimensions:—

Stem, diameter ..... 0.14 mm.

Hydranth-bearing ramule, diameter ..... 0.09 mm.

*Locality.* Creeping in small quantity upon *Eudendrium attenuatum*? and *Idia pristis*, both from St. 22, Hastings Harbour, 3 to 20 fathoms and shore, rock and sand.

Until the present record from the Indian Ocean, this species has been found only in the Australian region: Port Phillip, near low water (Lendenfeld, 1885, p. 351); Torres Straits—20 miles N.N.W. of Warrior Island, 5½ fathoms; Murray Island, 15 to 20 fathoms (Kirkpatrick, 1890, p. 607).

## Family CORYNIDÆ.

*CLADOCORYNE HADDONI* Kirkpatrick, 1890.

Except in size (for they are even more diminutive than those recorded by Kirkpatrick and Jäderholm), the Mergui specimens agree with the description and figures of the former, the double wrinkle at the base of the stalk being very evident. On occasion, one or two additional wrinkles may occur at the base of the stalks and, more seldom, on their middle portions; but in the majority of cases these rings are of little significance, since they belong to a new stalk regenerated after the destruction of the old one. Here,

as in simple Campanularian hydroids, regeneration is not content with simply adding a portion to the old stalk, but a complete new stalk is reproduced, springing from within the truncated end of the old one.

Dimensions:—

Stalk, length .....	0.43–0.98 mm.
„ diameter .....	0.06–0.08 mm.
Stolon, diameter .....	0.10 mm.
Hydranth, length.....	0.34–0.36 mm.
„ greatest breadth .....	0.11–0.21 mm.

Cnidoblast threads, armed with barbs such as Kirkpatrick has figured, accompany several of the hydranths. They are remarkable for their large size, the barbed portion being 6  $\mu$  in diameter from tip to tip of the barbs.

*Localities.* Rare hydranths on *Thyroscyphus vitiensis* and on *Idia pristis* from St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud. A solitary hydranth on *Idia pristis* and a few on *Corydendrium sessile* from St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand.

The species has been previously recorded only from Murray Island, Torres Straits, 15 to 20 fathoms (Kirkpatrick, 1890, p. 606); and, in Indian seas, from Paumben, 1 to 3 fathoms (Jäderholm, 1903, p. 263).

Family PENNARIIDÆ.

\*PENNARIA DISTICHA Goldfuss, 1820. Var. AUSTRALIS Bale, 1884.  
(= *Pennaria cavolinii* Ehrenberg, 1832.)

A few well preserved colonies, the largest 30 mm. high, represent this species. The ramules from which the hydranths project increase considerably in diameter upwards from their origin, where they bear three or four annulations, to the distal end, which is smooth. The number of filiform tentacles varies from nine to twelve, but there is much variation in the number of the capitate tentacles. The numbers depend, to some extent, upon the age of the hydranth, for the tentacles are fewest in those hydranths which, springing from ramules, lie towards the distal end of a branch—that is, in the youngest hydranths; for growth proceeds by the elongation of a branch, new polyps coming into being next to the terminal polyp, which is the oldest and the largest on the branch.

Pictet's careful comparative study of colonies of typical *P. cavolinii* from Naples, and of typical *P. australis* from Amboyna, makes clear that the latter form falls within the range of variation observed in the former species. But so definitely limited is the basal ringing of the ramules from which the hydranths arise, and so great a difference is there

in the proportions of the European and the Indo-Pacific forms, that I retain for the latter a distinct varietal name.

*Locality.* St. 29, reef off High Peaked Island, shore.

Although *P. carolinii* in its varying forms has been recorded from Eastern Australia (Bale, 1884, 1893; Lendenfeld, 1885), and from the East Indies (Pictet, 1893; Campenhausen, 1896; Weltner, 1900), the only records for the Indian Ocean are those of Warren (1906, 1907, and 1908, as *Halocordyle cooperi*, syn. *Pennaria australis*, var. *cooperi*) and that from Christmas Island in the paper following.

## II. CALYPTOBLASTEAE.

### Family HALECIDÆ.

*HALECIUM SIMPLEX* Pictet, 1893. (Plate LXXVII. figs. 10 & 11.)

This very rare species is represented by closely woven colonies covering the surface of a Polyzoon which is clustered at the base of colonies of *Corydendrium sessile*. The presence of the gonosome, so far undescribed, renders these specimens of particular interest.

**TROPHOSOME.**—To the naked eye the minute colonies are almost invisible, the hydranths being most easily discerned as they project from the surface on which the colonies grow, in close groups, resembling clusters of the smaller species of the entoproctan polyzoon, *Pedicellina*.

The stolon strands are of small diameter, but can often be traced for a considerable distance. Their courses are complicated, however, by the occurrence of offshoots, which, uniting with other stolons, form a network which lies closely upon the substratum, or is interwoven with it.

Short, unbranched, unwrinkled hydrocauli arise from the stolon at short distances from each other. Basally their diameter is small, but it gradually increases until, at the base of the hydrotheca, the girth of the hydrocaulus is about equal to that of the stolon. The hydrothecæ are very small. Their walls, which are well developed, form an inward curve to the margin, so that, instead of being flaring or trumpet-shaped, as in many species of *Halecium*, they are rather saucer-shaped. Very close to the margin occurs a ring of bright dots, chitinous prominences on the inner surface of the hydrotheca to which the hydranth was attached. Here the internal prominences are more highly developed than in any other species I have examined, for they sometimes rise into pronounced spines  $7\ \mu$  in length (Pl. LXXVII. fig. 11). Occasionally two or even three hydrothecæ occur in succession, a new hydrocaulus arising from within an old hydrotheca.

The hydranth is of great size. When contracted it is about twice as long as the hydrocaulus, but when extended it reaches a length of one millimetre or even more. It consists of a long

cylindrical neck, the base of which is attached to the hydrotheca at the chitinous projections already described. Distally this swells out into a very definite bulb, which is surmounted by a circle of from 18 to 20 tentacles. At the bases of the tentacles a ring of very large bean-shaped nematocysts,  $30\ \mu$  long by  $6\ \mu$  broad, surrounds the hydranth. Similar cells occur in the *cœnosarc* of hydrocaulus and stolon.

**Gonosome.**—This does not appear to have been described. A gonangium arises from the side of the hydrocaulus, about half-way between the hydrotheca and the stolon. The female gonangium is borne on a short stalk, and is roughly calceolate in shape, resembling the female gonangium of *H. beanii*, except that here the tubular orifice of the upper surface does not occur. All the gonangia I have examined contain ova to the number of about six. The male gonangium, therefore, remains unknown.

**Dimensions:—**

Stolon, diameter .....	0.06–0.07 mm.
Hydrocaulus, length .....	0.18–0.28 mm.
Hydrotheca, depth .....	0.024–0.027 mm.
„ diameter at margin .....	0.08–0.10 mm.
Gonangium, length .....	0.42–0.50 mm.
„ greatest diameter .....	0.17–0.21 mm.
Hydranth, length extended .....	1.05 mm.
„ „ contracted .....	0.78 mm.

**Locality.** Epizoid on a polyzoon associated with *Corydendrium sessile*, from St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand.

Hitherto recorded only from Amboyna, in the Moluccas (Pictet, 1893, p. 22), this record adds the species to the fauna of Indian seas.

**HALECIUM TENELLUM Hincks (?), 1861.**

The trophosomes are lax in habit, and in all other respects agree with Hincks's species; but, in the absence of the gonosome, confident identification is impossible, especially since the likeness between the trophosomes of young examples of the Australian *H. parvulum* Bale and *H. tenellum* appears to be almost perfect (see Markt-Turner, 1890, p. 218).

**Dimensions:—**

Stem, diameter .....	0.045 mm.
Hydrotheca, depth .....	0.024–0.030 mm.
„ diameter at margin .....	0.099–0.108 mm.

The dimensions of the Mergui specimens are considerably smaller than those of British examples.

**Localities.** Epizoid on *Thyroscyphus vitiensis* from Stations 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud.

Recorded with some doubt from Eastern Australia by Bale (1884, p. 65) and Lendenfeld (1885, p. 405), this widely dis-

tributed species has been described from the Indian Ocean only by Billard, from Macalonga, Mozambique, 22 metres (1907 *b*, p. 338).

#### Family CAMPANULARIDÆ.

##### CAMPANULARIA CORRUGATA Thornely.

Except at Station 1, where it was also associated with *Sertularella quadridens* and *Diphasia digitalis*, this species always occurred as an epizoon on *Idia pristis*.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; short and stout, strongly ribbed hydrothecæ on *Diphasia digitalis*, and long, cylindrical individuals on *Idia pristis*. Stt. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; occasionally. St. 22, Hastings Harbour, shore to 20 fathoms, rock and sand; fairly common. St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; not common. St. 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells and rock; rare cylindrical hydrothecæ with short stalks. St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; rare.

##### CAMPANULARIA RARIDENTATA Alder, 1857.

From British examples the majority of the specimens here referred to *C. raridentata* differ in lacking the swelling which intervenes between the base of the stalk and the stolon, in this respect resembling examples recorded from areas so wide apart as Calbuco, South America (Hartlaub, 1905, p. 567), St. Malo, France (Markt.-Turner, 1890, p. 205), and the Indian Ocean (Hincks, 1889, p. 133, *cf.* pl. xii. fig. 5). From seven to eleven rings occur at the base of the stem, and from three to five underneath the hydrotheca, and sometimes a few annulations mark also the middle portion of the stem. The margin of the hydrotheca appears to be divided into from five to seven large teeth, the extreme tenuity and transparency of which render them difficult to observe. The hydranth bears twelve to thirteen tentacles.

No gonosome was observed.

The dimensions of the Mergui specimens are much less than those of St. Malo specimens recorded by Marktanner-Turner-etscher (1890, p. 205), and approach most closely those of a single example from Saint-Vaast described by Billard (1907 *a*, p. 173), with which they also agree in possessing few hydrothecal teeth.

Dimensions, in mm.:—

	St. 1.	St. 23.
Stem, length .....	0.59	0.35-0.45
„ diameter .....	0.07	0.04-0.06
Hydrotheca, depth .....	0.50	0.29-0.41
„ diameter at mouth .....	0.17	0.13-0.15

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4-12 fathoms, sand and broken shells, and mud; rare. St. 25, Five Islands, 8 to 12 fathoms, rock and sand, and mud; rare. St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; rare.

Except from St. 23, where this species also occurs on *Sertularella quadrifida*, specimens are confined to *Idia pristis*.

From each of Stations 1 and 28 comes a solitary simply-stalked hydrotheca with cone-shaped basal portion, surmounted by almost cylindrical walls terminating in seven or eight sharp teeth. The structure of the basal portion resembles that of the hydrotheca of *Obelia andersoni* Hincks, but I regard the present specimens as abnormally developed examples of *C. raridentata*.

#### HEBELLA CALCARATA A. Agassiz, 1865.

One of the most widely distributed of the species in the collection, occurring at eight of the fourteen stations from which Hydroids were obtained. It shows considerable diversity of form, being usually represented by the long smooth hydrothecæ of the typical form, but frequently assuming the shape of the variety recorded by Marktanner (1890) as *Lafoëa contorta*. This epizoid species, like several others, shows a remarkable constancy of preference for *Idia pristis*, seeing that at all stations, with the exception of Station 9, where it was creeping on *Thyroscyphus vitiensis*, it occurred on that species, and on it alone.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; not common, often var. *contorta*. St. 9, between Bentinck Island and Courts Island, 12 to 26 fathoms, sand and shells. St. 14, Bushby Island pearling-ground, shore to 21 fathoms, sand and mud; rare. Stts. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; occasionally present, often assuming the shape of var. *contorta*. St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; very common, mostly var. *contorta*. St. 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells, and rock; very rare. Moskos Islands, 3 to 26 fathoms, rock and sand, or rock and mud; common.

#### HEBELLA CRATEROIDES Ritchie, 1909 b.

The hydrothecæ are smaller than those of the type specimens from the Andaman Islands. The hydranths are decayed, and no gonosome was observed.

##### Dimensions :—

Hydrotheca, depth .....	0.20 mm.
„ diameter at mouth.....	0.15-0.17 mm.

*Localities.* Stts. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; rare, on *Lytocarpus phœniceus*.

THYROSCYPHUS REGULARIS Jäderholm, 1896. (Plate LXXVII. fig. 7.)

(*T. æqualis* Warren, 1908.)

**TROPHOSOME.** The specimens are somewhat larger than those originally described, sometimes almost 20 cm. in length, while the branches may reach a length of 45 mm., in place of the maximum of 18 mm. given by Jäderholm.

The species is readily distinguished from *T. vitiensis* by the presence of a very distinct operculum, accompanied by deep bays round the margin; further, the bright rim runs in this case much nearer to the edge, and is not so pronounced, while the faint ringling at the internodes is more marked. The joints, varying in number, which are said to occur on the peduncle, are only occasionally present (though sometimes up to three or four were observed), and even then they are not essential to the specific structure, for they are due to the destruction of the hydrotheca, and to the subsequent regeneration of a new hydrotheca from within the remains of the old one, the apparent joints being the reliquæ of former calyces. No specific value can attach to these accidental "joints," the like of which I have already observed in *Thyroscyphus simplex* = *tridentatus* (1909, p. 75, fig. 1 b) and in *Lytoscyphus marginatus*; but in *T. ramosus* the semblance of a twist occurs in the peduncle.

The minute structure of the cœnosarc is obscured by the presence of opaque granules which occur in great abundance. In these specimens the hydranth is attached, not to a continuous ridge, as in the specimens from Natal, which Warren has described as *T. æqualis* (and which I am unable to distinguish from *T. regularis*), but to a row of small chitinous prominences which runs round the inside of the hydrotheca in an exceedingly sinuous curve, having two maxima, one on the adcauline, the other on the abcauline surface, and two lateral minima.

**GONOSOME.** Gonangia, which have not previously been described, were found on a single colony from Station 25 (Pl. LXXVII. fig. 7). The cœnosarc has disappeared, but the perisarc is in the form of a long cylinder, larger even than that of *T. torresii* (see Jäderholm, 1903, p. 273). Very indefinite and irregular wrinkles appear on the perisarc. The insignificant stalk of the gonangium arises from the projection of the internode upon which a hydrotheca is perched.

Dimensions:—

Branch, diameter .....	0.36 mm.
Distance between hydrothecæ .....	1.13 to 1.3 mm.
Hydrotheca, depth .....	0.96 mm.
"    breadth at mouth .....	0.63 mm.
Peduncle, diameter.....	0.20 mm.
Gonangium, length.....	3 mm.
"    breadth .....	1 mm.

**Localities.** A large bunch of colonies from St. 22, Hastings [13]

Harbour, shore to 20 fathoms, rock and sand. St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; two colonies. St. 25, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; many colonies.

This species has already been recorded from the China Sea (Jäderholm, 1896, p. 9), and from Bird Island, Algoa Bay, Cape Colony (Warren, 1908, p. 344, as *T. aequalis*).

*THYROSCYPHUS VITIENSIS* Marktanner-Turneretscher, 1890.

A widely distributed species, occurring at eight of the fourteen stations from which Hydroids were obtained. In this, as in *T. regularis*, the hydranth is attached to a row of minute chitinous prominences on the inside of the lower portion of the hydrotheca. These are arranged as in the previous species, but they are more strongly developed, and are placed on a slightly raised portion of the hydrothecal wall.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; common. St. 3, French Bay, King Island, and south end of Iron Island, 3 to 8 fathoms, mud and rock, or sand; common. St. 9, between Bentinck Island and Courts Island, 12 to 26 fathoms, sand and shells; rare. St. 14, Bushby Island pearling-ground, shore to 21 fathoms, sand and mud; rare. Stts. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; rare. St. 19, Paye Island and Pink Island, 7 to 9 fathoms, rock and sand; rare. St. 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells, and rock; fairly common. St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; rare.

Family CAMPANULINIDÆ.

*OPERCULARELLA LACERTA* Johnston, 1847.

Identification depends upon trophosome characters alone, the gonosome being absent. I can detect nothing, however, which could distinguish these specimens from North Sea examples of the above species. It occurs in its simplest form, a creeping stolon, sending up here and there short ringed stalks, on each of which is poised an exceedingly hyaline hydrotheca.

Dimensions:—

Hydrotheca, depth *	0.21 mm.
diameter	0.08–0.09 mm.
Peduncle, diameter	0.04 mm.

*Locality.* Moskos Islands, 3 to 26 fathoms, rock and sand, or rock and mud; rare, growing on a stem of *Plumularia setacea*.

Although the range of the species is a wide one, for it has been recorded from the North of Europe, from both sides of the

\* From top of operculum.

North Atlantic Ocean, and from the Western Pacific (China and Eastern Australia), it has not hitherto been found in the Indian Ocean.

*CALYCELLA OLIGISTA* \*, sp. n. (Plate LXXVI. figs. 3 & 4.)

**TROPHOSOME.** The colony is epizoic, and consists of a creeping, delicate stolon which lies in close contact with the specimen upon which it occurs. From this stolon hydrothecæ spring at irregular intervals.

The hydrothecæ are exceedingly minute, delicate, hyaline, and transparent, without a trace of the smoky tint which characterises *C. syringa*. In shape they are tubular and cylindrical, of approximately the same diameter for the greater portion of their length, although the proximal half is usually slightly bulged, and tapers, more or less rapidly, to join the stalk. The margin of the hydrotheca, which is very slightly everted, is definite, and is of considerable strength, for it is seldom that it is found in a collapsed condition. It is divided into shallow crenulations, similar to those in *C. syringa*, each of which subtends the base of an opercular valve. In no case was a duplication of the margin noticed. The operculum is distinct from the hydrothecal wall, and is composed of about twelve to fourteen exceedingly delicate valves, difficult to distinguish. The cavity of the hydrotheca is separated from that of the stalk by a distinct but delicate diaphragm. The stalk is usually very short, so that the hydrotheca almost rests on the stolon, but in one case (Pl. LXXVI. fig. 3) a well developed stalk was observed. This stalk was marked by a few irregular indentations, but in other cases the stalks were smooth, and ringing of a regular nature never occurred.

The hydranth is large compared with the size of the hydrotheca. It is attached by a basal disk to the hydrothecal wall immediately above the diaphragm, and is continued upwards as a cylindrical body with conical hypostome, surrounded by a whorl of about seven to ten tentacles. The ectoderm is thick, and the tentacles, in contraction, are dumpy and stout.

The gonosome was not observed.

**Dimensions:—**

Stolon, diameter .....	30 $\mu$ .
Hydrotheca, depth .....	120-138 $\mu$ .
„ greatest diameter .....	45-66 $\mu$ .

**Localities.** St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; very rare, on *Idia pristis*. St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; very rare, on *Idia pristis* and *Thyroscyphus vitiensis*.

**Systematic position.**—This species differs remarkably in size, colour, texture, and in the development of the peduncle and its ringing from *C. syringa*, although there is a similarity between

\* *ὀλιγίστος*, smallest.

its hydrothecæ and some of the varieties of the latter species (see Broch, 1909 *b*, text-fig. 22). It approaches most closely *C. nuttingi* Hargitt (1909, p. 378), from which it differs in being smaller in size, in being cylindrical instead of tapering from hydrothecal margin to base, and in lacking distinctly annulated peduncles, with "annulations occasionally extending some distance (rarely over the entire body) on the thecal walls."

I regard the unnamed specimen, mentioned and figured by Miss Thornely (1908, p. 83, pl. ix. fig. 5), from Khor Shinab, 10 to 12 fathoms, in the Soudanese Red Sea, as belonging to this species.

*CUSPIDELLA COSTATA* Hincks, 1868. (Plate LXXVII. fig. 8.)

To the short and incomplete description given by Hincks the following observations may be added. The hydrotheca is cylindrical for the greater part of its length, but near the base it gradually tapers downwards. Frequently the basal portion of the hydrotheca lies along the object upon which the epizoon is growing, the distal portion bending upwards at an angle, slightly after the manner of *Lafoëa serrata*. Within the bent portion the retracted polyp is generally found. Similar bent hydrothecæ have been described by Dr. Billard from La Hougue (1904, p. 165).

The lines of growth held to be characteristic of the species, and clearly marked in our specimens, are not lines of growth in the ordinary sense, marking the place where new growth has commenced. They indicate, instead, the margins of earlier hydrothecæ, the opercular flaps of which occasionally remain attached and give an appearance of longitudinal fluting to the succeeding portion of the hydrotheca, as is suggested in the terminal segment in Hincks's figures (1868, pl. xl. figs. 5, 5 *a*). The secondary hydrotheca (produced probably on the regeneration of an entirely new hydranth) lies within the primary, and for some distance their walls, though in close contact, remain distinct. The tertiary, when such occurs, lies within the secondary, and so on. Thus the terminal segment is, as Hincks observes, "of thinner material than the rest," for its walls are those of a single hydrotheca, while proximal to the uppermost segment the walls, owing to the telescoping arrangement, are considerably strengthened. It is noteworthy that the proximal segment is usually of distinctly less calibre than its successors. The operculum of the hydrotheca is composed of about 14 or 15 flaps.

The hydranth is strongly retractile, retiring on contraction to the proximal third of the hydrotheca. It appears to have about six to eight tentacles, which are closely set with whorls of large oval nematocysts, the whorls being  $7.5\ \mu$  apart. The average size of the nematocysts in these whorls is  $5.2\ \mu$  long by  $2\ \mu$  broad, but at the tip of the tentacle larger examples occur,  $10.5\ \mu$  long by  $5\ \mu$  broad.

No gonosome was observed.

## Dimensions:—

Hydrotheca, length .....	0.7-1.12 mm.
diameter .....	0.10-0.14 mm.
Length of flaps of operculum .....	0.11-0.13 mm.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; rare hydrothecae on *Thyroscyphus vitiensis*. St. 3, French Bay, King Island, and south end of Iron Island, 3 to 8 fathoms, mud and rock, or sand; very rare, on *Thyroscyphus vitiensis*.

## Family LAFOEIDÆ.

## LAFOEA SERRATA Clarke, 1879.

A widely distributed, but moderately rare species. Repeated regeneration of the hydranth had furnished one hydrotheca (from St. 22) with the exceptionally large number of eleven successive margins.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; fairly common, on *Idia pristis*. St. 9, between Bentinck Island and Courts Island, 12 to 26 fathoms, sand and shell; very rare, on *Thyroscyphus vitiensis*. Stt. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; rare, on *Idia pristis*. St. 22, Hastings Harbour, shore to 20 fathoms, rock and sand; fairly common, on *Thyroscyphus vitiensis* and *Idia pristis*. St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; rare, on *Endendrium attenuatum*? St. 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells, and rock; rare, on *Idia pristis*. St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; rare, on *Idia pristis*.

## LAFOEA VENUSTA Allman(?), 1877. (Plate LXXVI. figs. 5 &amp; 6.)

Various Hydroids have associated with them a small form which I refer, with a query, to this species.

The trophosome consists of a creeping hydrorhiza from which spring small cylindrical hydrothecae, set on stout but variable stalks, and zoned by numerous, well-defined, and regular corrugations. These decrease in distinctness towards the base of the hydrotheca. The margin of the hydrotheca is everted, and the stalk bears no regular rings. A marked and distinctive character exists in the colour of the perisarc which possesses a brownish-smoke tint, slightly variable in density. An exceedingly delicate membrane forms the floor of the hydrotheca.

The hydranth is cylindrical and minute, furnished with a hemispherical hypostome, surrounded by tentacles varying in number from nine to eleven. The tentacles and body of the hydranth have a granular appearance owing to the presence of scattered nematocysts, which do not seem, even in the tentacles,

to be arranged in whorls, and of large, deeply stainable cells in the body-wall.

The habit of this epizoon is peculiar, for, in addition to the ordinary external meandering, the cœnosarc may live within the perisarc of the hydroid upon which it grows. Thus in several cases, the hydrothecæ of this species project from within the hydrothecæ of *Idia pristis* and *Sertularella quadridens*. In this respect much resemblance is shown to the habit of *Lafoëa dispoliensis*, Warren (1909, p. 105), the wanderings of which within the perisarc of its host, *Sertularia bidens* Bale, have been closely traced by Dr. Warren. In the present case the material being in a poor state of preservation, I have been unable to trace the course of the parasite throughout.

Dimensions:—

Hydrotheca, length.....	0.53-0.84 mm.
"          greatest diameter .....	0.21-0.27 mm.
Peduncle, diameter.....	0.075-0.081 mm.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; solitary hydrothecæ on *Idia pristis* and *Sertularella quadridens*. St. 14, Bushby Island pearling-ground, shore to 21 fathoms, sand and mud; rare, on *Idia pristis*. Stt. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; very rare, on *Idia pristis*. St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; very rare, on *Sertularella quadridens*.

Hitherto this species has been found only on the western sea-board of the North Atlantic Ocean, and growing upon only one host, *Lytoscyphus marginatus* Allman: Loggerhead Key, 9 fathoms (Allman, 1877), 10 miles north of Zoblos Island (Clarke, 1879), Anguilla, Antilles, 100-150 fathoms (Jäderholm, 1903), off Bermuda, 30 fathoms (Ritchie, 1909 a), and Prof. S. F. Clarke, in *litteris* 1909, mentions its occurrence at West Florida, 20 fathoms, again on *Lytoscyphus marginatus*.

*Systematic position.*—The general appearance of the specimens described as *Lafoëa venusta* resembles that of a small parallel-sided form of the exceedingly variable *Campanularia corrugata* Thornely. As the gonosomes of both species are unknown, and even the hydranth of the former is undescribed, the difficulties of identification are thus greatly increased. The present specimens are, however, specifically distinct from *Campanularia corrugata*, on account of the much smaller size of their hydrothecæ, which are also more regularly ringed, and are always cylindrical in shape. The hydranths also differ in shape and in structure. Those of the present specimens are more slender and possess 9 to 11, in place of 22 tentacles; they have a more hemispherical hypostome, and lack the peculiar development of those endodermal cells, which, in *C. corrugata*, project from the base of the tentacles into the gastric cavity, almost meeting there below the

hypostome, and reminding one of the structure of *Bonneviella grandis*, described by Broch (1909 a, p. 195). I have not noticed that in Miss Thornely's species the perisarc is tinged with brown.

To *Lafoëa venusta* I have, with a little doubt, referred my specimens because of the shape, the small size, and the corrugated walls of the hydrotheca.

#### Family SERTULARIDÆ.

SERTULARELLA CYLINDRICA Bale, 1888. Var. PUSILLA, nov. (Plate LXXVII. fig. 9.)

Simple stems spring from a creeping stolon, and these are divided into internodes of exceeding variable length by slightly slanting nodes. At the distal end of each internode a hydrotheca is borne.

The hydrothecæ are alternate, and have very thin, collapsable walls, in strong contrast with the thick internodal perisarc. In comparison with the stem upon which they are carried, the hydrothecæ are very large. In shape they are cylindrical, the cylinder expanding slightly at the mouth and forming an everted margin, entire, and destitute of operculum. For about a third of their length they are adnate to the internode, but beyond this their free portion curves gracefully away from the stem, so that the aperture faces upwards and outwards, the plane in which it lies meeting the stem at an angle of about 45°. A slight break in the even abcauline profile of the hydrotheca opposes the point where the adcauline side becomes free from the stem. Often the bottom of the hydrotheca is rounded. Stolons are occasionally developed from the stems, and one was observed springing from the inside of a hydrotheca.

Gonosome unknown.

Dimensions:—

	Var. <i>pusilla</i> .	Typical form.*
Internodes, length .....	0.27-0.36 mm.	very variable.
„ diameter .....	0.06-0.07 mm.	up to 0.39 mm.
Hydrotheca, depth .....	0.29-0.37 mm.	0.80-0.84 mm.
„ diameter at mouth .....	0.10-0.11 mm.	0.32 mm.

*Localities.* St. 32, south-west of Domel Island, 26 to 29 fathoms, sand and mud; rare, on *Lythocarpus phæniceus*. Moskos Islands, 3 to 26 fathoms, rock and sand, or rock and mud; a single stem amongst the rhizoidal tubes of *Idia pristis*.

The species has hitherto been found only on the east coast of Australia, at Port Jackson (Bale, 1888, p. 765).

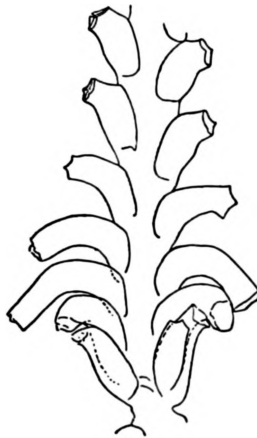
*Systematic position.*—While I do not find in this form characters sufficient to separate it specifically from *C. cylindrica*, it can readily be distinguished from the Australian form, examples of which I have recently had an opportunity of examining, chiefly

\* Specimens collected off New South Wales by the 'Thetis,' 1898, entrusted to me for examination.



Considerable variation occurs also in the proximity of the hydrothecæ of the same lateral series, for while a marked gap separates some—usually on the distal portions of branches—in many cases the upper portion of one hydrotheca is pressed against the base of the next (cf. Pl. LXXVII. figs. 12 *a*, 12 *b*). An abnormality in the formation of the hydrothecæ is worth noting. Occasionally, probably after some accident to the branch, the hydrothecæ first formed thereafter, while normal so far as the adnate portion is concerned, have an exceptionally long portion free (0.77 mm., as contrasted with the average 0.1 mm.), this part being tubular, recurved, and having a rather indefinite margin. Its successor is less, though still abnormally large, and the diminution continues until the normal size is reached after five or six hydrotheca-pairs (text-fig. 79).

Text-fig. 79.

Abnormal hydrothecæ of *Sertularella quadridens*,  $\times 20$ .

The pinnæ, each of which arises beneath a hydrotheca, are regularly alternate, three hydrothecæ being interposed between two pinnæ on the same side. In one case a branch, of second degree, was observed to spring from the lumen of a hydrotheca.

The structures of the soft parts of the species, to which I have seen no reference, show points of interest. The cœnosarc of the stem is arranged in a varying number of longitudinal strands, usually three or four, which are connected irregularly by anastomosing canals, and which, with their connections, line the perisarc. In the branches the structure is less complicated. There, two large longitudinal cœnosarc tubes are to be distinguished, one running along each side of the branch, and threading its way

between the hydrothecæ. These are connected at the base of each hydrotheca by a strong bridge of cœnosarc, upon the middle of which the base of the hydranth rests. These structures closely resemble those which Nutting has observed in *Selaginopsis ornata* (1904, p. 7), allowing for the differences in symmetry due to the presence of four series of hydrothecæ in that species, in place of two in this. Although each tube possesses a thick definite ectoderm, I have been unable to distinguish the perisarc which, Nutting supposes, surrounds each cœnosarc tube.

The structure of the polyp is like that of *Thuiaria robusta*, as figured by Nutting (1904, p. 11, fig. 15). It has a large blind sac, and clumps of large endodermal cells project into the hydranth cavity except from the abcauline wall of the blind-sac, where the development of the endoderm is insignificant. The protractor band is attached, not to the abcauline wall of the hydrotheca, but to varying points of the lateral wall in the neighbourhood of the margin of the hydrotheca.

The gonosome was not observed.

Dimensions:—

Stem, diameter .....	0.56–0.77 mm.
Stem internode, length .....	2 mm.
Hydrotheca, length adnate.....	0.46–0.49 mm.
"      "      free .....	0.07–0.14 mm.
"      diameter at mouth .....	0.21–0.22 mm.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; several fragments. St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; one colony. St. 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells, and rock; one colony.

Previously known only from Eastern and Northern Australia; Port Curtis and Holborn Island (Bale, 1884), Peel Island, Moreton Bay (Bale, 1888), Flinders Passage, Torres Strait (Allman, 1888, as *Thuiaria vineta*\*), Thursday Island (Weltner, 1900).

IDIA PRISTIS Lamouroux, 1816.

One of the commonest of the species in the collection, found at eight of the fourteen stations at which Hydroids were obtained. There is much variability in the length of the free portion of the hydrotheca, the sloping operculum appearing, in some cases, to project directly from the surface of the stem, while in others a large part of the hydrotheca stands out at right angles to the stem. Occasionally, too, the adcauline operculum is lacking in definiteness, the upper wall of the hydrotheca simply meeting the lower as an indefinite flap. Many of the branches from Station 35 end in stolons, indistinguishable from those which project from the hydrorhizal tubes.

\* See Billard, 1908, p. 2 of separate copy.

*Localities.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; common. St. 14, Bushby Island pearling-ground, shore to 21 fathoms, sand and mud; common. Stt. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; common. St. 22, Hastings Harbour, shore to 20 fathoms, rock and sand; common, with gonangia, some colonies growing on a sponge. St. 23, Five Islands, 8 to 12 fathoms, rock and sand, and mud; fairly common. St. 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells and rock; common. St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; one colony. Moskos Islands, 3 to 26 fathoms, rock and sand, or rock and mud; common, with gonangia.

*DIPHASIA DIGITALIS* Busk, 1852.

In these specimens it is clearly seen that the two so-called opercular muscles are attached, not to the valves of the operculum, but to the lateral walls of the hydrotheca near the margin, and are, in function, protractor muscles (see Nutting, 1904, p. 13, fig. 17). The hydranth possesses about twenty tentacles.

*Locality.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; several small colonies, on the bare axis of an Alcyonarian, and on *Idia pristin*.

Recorded from the Western Indian Ocean—Maldives Islands—by Borradaile (1905, p. 842); this is the first record from the Eastern Indian Ocean.

*SERTULARIA TURBINATA* Lamouroux, 1816.

(=*S. loculosa* Busk 1852 \*.)

Several small, unbranched colonies of this species occur upon *Thyroscyphus vitiensis*. They are pale in colour, in this, as well as in the shortness of the internodes, agreeing with the specimens described from Paumben, India, by Jäderholm (1903). But they differ in the reduction of the lateral teeth, which are occasionally so indistinct that the aperture appears to be almost round. Besides an indistinct tooth on each flank, the hydrotheca is surmounted by a small third tooth, from the summit of which a membranaceous edge sometimes runs to the lateral teeth. Notwithstanding difficulties of observation, I feel assured, after examining many hydrothecae, that the operculum is formed of a solitary flap, hinged on the distal edge of a slight thickening which occurs on the abcauline margin of the hydrotheca. Although membranes unite the superior with the lateral teeth, these do not hinge inwards, and can scarcely, therefore, be accounted part of the operculum. They are the less necessary since the abcauline flap is of diameter sufficient completely to close the aperture of the hydrotheca.

\* Fide Billard (1909, p. 322), who has examined the type specimen of Lamouroux.

In the structure of the operculum *S. turbinata* appears to differ from *S. versluyysi* Nutting (1904)—regarded by Billard (1908) as a synonym—for in the latter, as Congdon states (1907, p. 482), and as careful examination of the lateral aspect of specimens from Cape Verde Islands, in my collection, shows, the operculum is furnished with a large abcauline and two smaller latero-adcauline valves.

The protractor of the hydranth, which possesses only a small blind-sac, is attached to the hydrothecal wall at the intrathecal ridge.

*Localities.* Stt. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; not common.

#### Family PLUMULARIDÆ.

##### PLUMULARIA SETACEA Linnæus, 1758 (?).

A single immature colony, 15 mm. high, identical in all respects with North Sea specimens. I have written the designation with a mark of interrogation on account of the impossibility of distinguishing the trophosome of this small variety from that of *P. strictocarpa* Pictet (1893), from Amboyna.

*Locality.* Moskos Islands, 3 to 26 fathoms, rock and sand, or rock and mud.

##### PLUMULARIA sp.

An unidentifiable fragment, the structures of the stem and hydroclades of which resemble those of *P. setacea*, but the fragment shows traces of branching, and the hydrotheca of having a slightly concave contour.

*Locality.* St. 32, Hastings Harbour, shore to 20 fathoms, rock and sand.

##### ANTENELLA SECUNDARIA Gmelin, 1788-93.

The nematocysts of the nematophores measure  $12\ \mu$  by  $4\ \mu$ , agreeing with Warren's measurements of those in *A. natalensis*, which I regard as a synonym. There are about 18 tentacles.

*Locality.* St. 1, east of Tavoy Island and Port Owen, 4 to 12 fathoms, sand and broken shells, and mud; not common, on *Idia pristis*.

##### LYTOCARPUS PENNARIUS Linnæus, 1758.

A widely distributed species, represented by several fine colonies, one of which reached a height of 95 cm. Apart from the prominent anterior tooth, that on the margin of the hydrotheca second from the stem is distinctly the largest. It forms the highest point on the outwardly curved margin of the hydrotheca. There is, however, some variation in the prominence of

the teeth in general. The margin of the mesial sarcotheca is slightly sinuated.

The attachment of the hydroclades to stem and branches is weak, for, whenever an attempt is made to clear the specimen of flesh, by immersion in a solution of sodium hydrate, the hydroclades invariably fall off.

The soft parts of the specimens from Station 9 are well preserved, as the preservation of Plumularians in general collections goes. The tentacles are about sixteen in number. The whole of the inside of the hydrotheca, practically to the margin, is lined with a thin layer of ectoderm, with which the hydranth is in connection by means of exceedingly numerous strands which, proceeding from its ectodermal layer, give the appearance of filling the space between hydrotheca and hydranth with a delicate open meshwork. An opening leads from the hydrotheca cavity to that of the mesial sarcotheca, immediately proximal to the point where the sarcotheca joins the hydrotheca, and through this passes a strand of cœnosarc, connecting sarcostyle and hydranth.

A hydrotheca was observed, abnormal in lacking a mesial sarcotheca.

*Localities.* Specimens from Stt. 9, 18, 19, 25 bore phylactocarps. St. 9, between Bentinck Island and Courts Island, 12 to 26 fathoms, sand and shells; one colony. St. 18, west and south-west of Paye Island, 10 to 21 fathoms, sand, shells and rock; a large colony. St. 19, Paye Island and Pink Island, 7 to 9 fathoms, rock and sand; fragment. St. 25, Gregory Group and Crichton Island, 4 to 14 fathoms, stones and broken shells, and rock; three colonies. Moskos Islands, 3 to 26 fathoms, rock and sand, or rock and mud; fragment.

*LYTOCARPUS PHENICEUS* Busk, 1852.

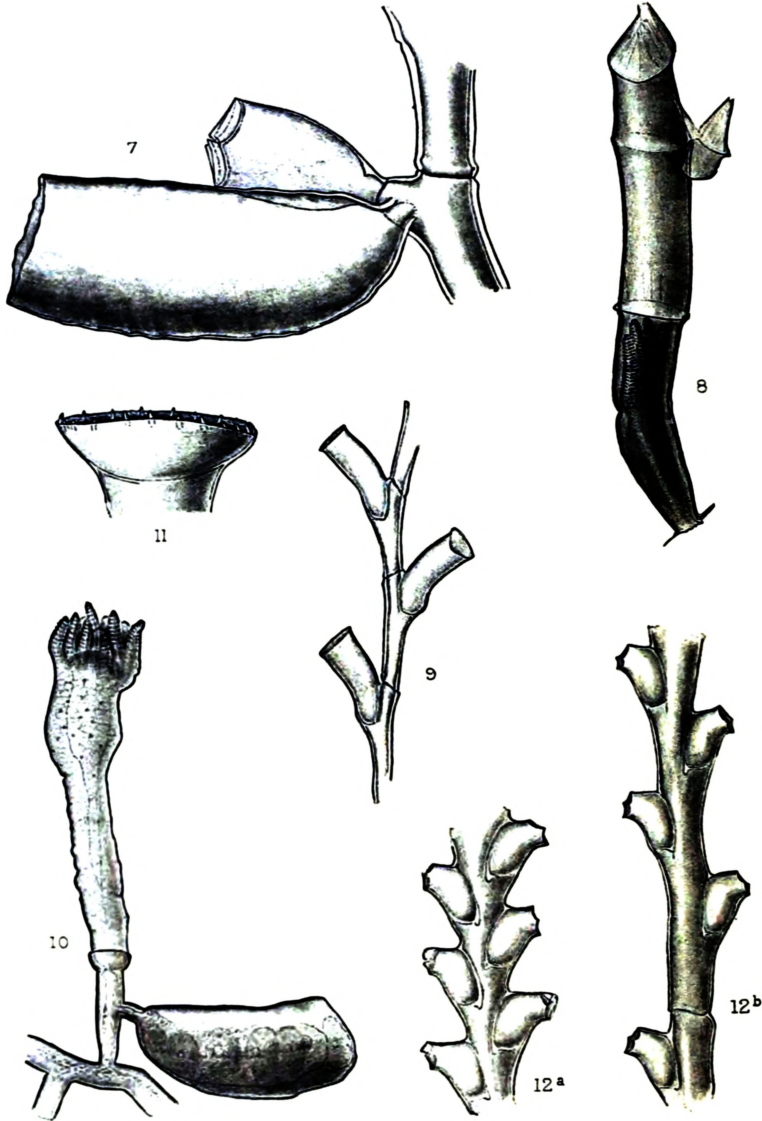
The hydrothecæ of these specimens approach most closely those of Bale's fig. 2, pl. xv., 1884, although the chitinous septa and walls are not so strongly developed in my specimens, and the small lobe at the back of the hydrotheca is not produced into a tooth. There are two sarcothecæ at the base of each hydroclade—one proximal, the other lateral—and, in addition, a sarcostyle issues through a mere perforation with raised lips, on the anterior of the stem-process on which the hydroclade is borne.

*Localities.* Stt. 15 and 16, Ravenshaw Island, Sir John Malcolm Island, and Alligator Rock, 5 to 18 fathoms, rock and sand, or rock and mud; three colonies. St. 32, south-west of Domel Island, 26 to 29 fathoms, sand and mud; one colony. St. 35, between Warden Island, Howe Island, and Lyall Island, 15 to 20 fathoms, rock and sand; one colony. Moskos Islands, 3 to 26 fathoms, rock and sand, or rock and mud; one colony.

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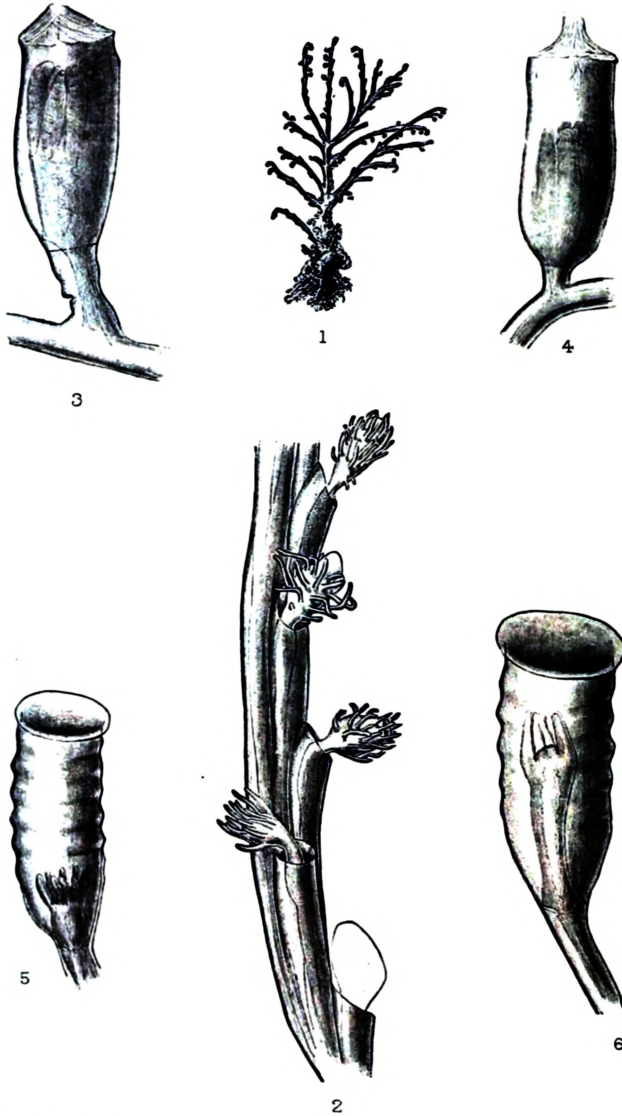


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## EXPLANATION OF THE PLATES.

## PLATE LXXVI.

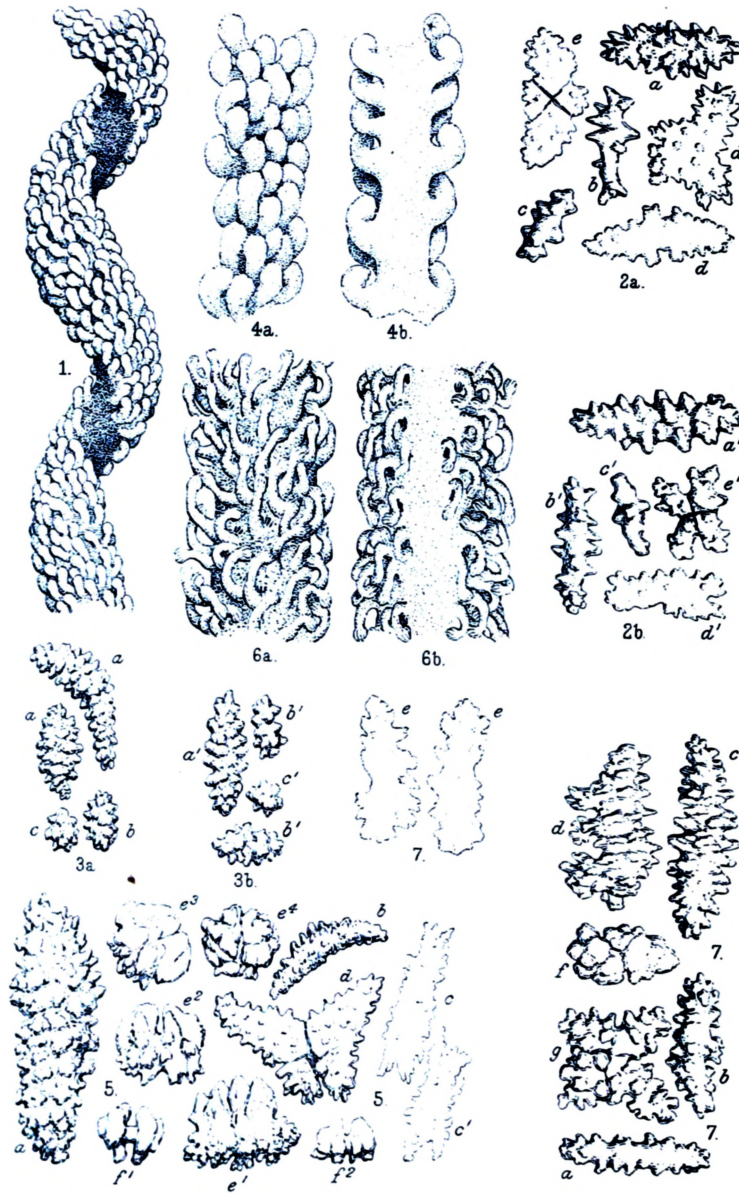
- Fig. 1. *Corylindrium sessile*, sp. n. Complete colony. About nat. size.
2. " " Portion of branch with hydranths.  $\times 25$ .
3. *Calycella oligista*, sp. n. Hydrotheca and hydranth.  $\times 230$ .
4. " " " " " "
5. *Lafoëa venusta* Allman (?). Hydrotheca and hydranth.  $\times 60$ .
6. " " " " " "

## PLATE LXXVII.

- Fig. 7. *Thyroscyphus regularis* Jäderholm. Portion of branch with hydrotheca and gonangium.  $\times 25$ .
8. *Cuspidella costata* Hincks. Hydrotheca, showing character of annular markings.  $\times 70$ .
9. *Sertularella cylindrica*, var. *pusilla*, nov. Portion of stem, with hydrothecae.  $\times 46$ .
10. *Halecium simplex* Pictet. Trophosome and gonosome.  $\times 70$ .
11. " " Hydrotheca, showing internal chitinous projections.  $\times 310$ .
12. *Sertularella quadriceps* Bale. Showing variation in remoteness of hydrothecae. (a) Proximal portion of branch. (b) Distal portion of same branch. Each  $\times 19$ .







XIV.—*Hicksonella*, a New Gorgonellid Genus.

By JAMES J. SIMPSON, M.A., B.Sc.  
(Carnegie Fellow, University of Aberdeen).

(Read October 19, 1910.)

PLATE XIII.

IN my recently published "Revision of the Juncellid-group of the Gorgonellidæ,"\* I did not include any notice of the unique form described by Professor S. J. Hickson under the name of *Juncella spiralis*. Its puzzling and divergent character made a separate discussion advisable.†

In the Revision the Juncellids were divided into three genera, namely, *Juncella*, *Scirpearia*, and *Nicella*, and an examination of the diagnoses given there, along with the following descriptions,

\* Proc. Roy. Irish Acad., No. 7 (1910) pp. 247-386 (19 pls.).

† I wish to take this opportunity of thanking Professor J. Arthur Thomson for entrusting these forms to me for identification and description, and also the Carnegie Trust for a grant to cover the cost of the illustrations.

EXPLANATION OF PLATE XIII.

- Fig. 1.—Portion of *Hicksonella spiralis*, enlarged to show the spiral form and also the distribution and nature of the verrucæ. × 3.  
,, 2.—Spicules from the verrucæ of ditto: (a) near base, (b) near tip.  
,, 3.—Spicules from the coenenchyma of ditto: (a) near base, (b) near tip.  
,, 4.—Two views of the same portion of *H. flagellata* sp. n.: (a) polyp-bearing, (b) non-polyp-bearing aspect. × 4.  
,, 5.—Spicules of ditto.  
,, 6.—Two views of the same portion enlarged of *H. capensis* sp. n.: (a) polyp-bearing, (b) non-polyp-bearing aspect. × 4.  
,, 7.—Spicules of *H. capensis* sp. n.

will show the impossibility of linking the specimens now under consideration to any of these genera. It will be shown that it is necessary to establish a new genus.

As a full description of the *Juncella spiralis* type has been given by Hickson,\* we may briefly consider some of the most characteristic features before proceeding to any taxonomic consideration. The colonies were all unbranched; one of them was 220 mm. in length without the base, which had been broken off. The axis was pale brown in colour, and had rings of lime embedded in the horny matrix. The verrucæ were all prominent and arranged irregularly on two-thirds of the circumference of the stem, leaving a bare track on one side free from verrucæ from end to end of the colony. The bare track and verrucæ were covered with a dense armature of spicules, and "it is difficult to believe that the verrucæ can ever be retracted." The spicules consisted chiefly of irregularly tuberculated plates and spindles. "The spicules are tightly jammed together to form an impenetrable armour. The surface of the verrucæ has a distinctly squamate appearance, the plate-like spicules slightly over-lapping."

*Hicksonella* † *spiralis* g.n. (= *Juncella spiralis* Hickson).

Plate XIII. figs. 1-3.

Two specimens referable to this species occur in a collection from Cape Colony. Professor Hickson very kindly sent me a small portion of his type specimen for examination, and one of the present colonies agrees with it in almost every feature. It is 40 cm. in length, the diameter is 3.5 mm. near the base, and about 2 mm. at the tip. The tapering is thus very gradual, in fact at a distance of 7 cm. from the tip there is very little difference in the diameter from that at the base.

Another specimen is 20 cm. in length, and has a maximum diameter of 2.5 mm. at the base. In both specimens the basal part is wanting.

The axis is densely calcareous, and very hard in the lower portion, so that, except near the apex, the colony is very rigid. It is composed of concentric laminæ of the typical Gorgonellid type. There is a distinct, central, more densely calcareous portion, and the surface is marked by a series of minute longitudinal furrows. The diameter near the present base is 1.5 mm., but this diminishes gradually to a hair-like fineness at the tip.

\* The Alcyonaria of the Cape of Good Hope. Part II., Marine Investigations in South Africa, iii. (1904) pp. 231-33 (4 figs.).

† I wish to associate with this new and remarkable genus the name of Professor Sydney J. Hickson, D.Sc. F.R.S., who has done so much to elucidate the structure and relationship of Alcyonarians, and to whom we are indebted for the original observations on *Hicksonella*.

The cœnenchyma is very thin and densely spiculose; when dry it is extremely brittle.

The canal system is difficult to determine owing to the thinness of the cœnenchyma. It was found impossible to detach a portion of the cœnenchyma from the axis without damaging the canals. Serial sections were made from a decalcified portion of the cœnenchyma, but the results were not very satisfactory. The furrows on the axis suggest a concentric series of canals separating the cœnenchyma from the axis, but it is very doubtful whether one or more of these is larger than the others, and the possession of an outer series of canals is quite uncertain.

From end to end of the colony there is a narrow streak devoid of polyps, which participates in the spiral arrangement of the colony (pl. XIII. fig. 1). It occupies between one-fourth and one-third of the circumference of the cœnenchyma. The remaining three-fourths to two-thirds is densely covered with small elongated verrucæ. In the smaller specimen the basal portion, for a distance of 8 cm., is devoid of polyps.

The verrucæ are long and club-shaped, and somewhat resemble those of *Scirpearia flagellum*; the terminal part is considerably enlarged. They are about 1.5 mm. in length, and about 0.5 mm. in diameter at the widest part. They are very spiculose, and the surface, when viewed with a lens, reveals a series of minute horizontal, overlapping scales, which recalls the armature of a Caligorgid.

At the utmost they are only feebly retractile into the cœnenchyma, but their enormous size, the thinness of the cœnenchyma and their dense armature, would seem to preclude the possibility of any great degree of retraction.

When the tentacles are inturned there is a distinct eight-rayed figure at the summit of the verrucæ, and the scales on the aboral surface of the tentacles form a sort of pseudo-operculum. Further retraction of the tentacles results in a very definite horizontal wrinkling of the verrucæ.

The verrucæ are very densely packed on the polyp-bearing region, and about a dozen occur on one transverse line.

Young polyps occur scattered among the older ones, and so render any definite arrangement impossible.

In the larger specimen the colour of the cœnenchyma in the bare tract is a dark brick-red, but the verrucæ are creamy white with an occasional trace of an orange tint. In the smaller specimen the bare tract is also reddish-orange, but the polyps are pinkish-purple.

The spicules of this species are extremely characteristic, but very diverse in form and irregular in outline.

The figs. 2 *a*, *b* and 3 *a*, *b*, show some of the more definite types.

Fig. 2 shows those of (a) the verrucæ near the base, (b) the verrucæ near the tip.

Fig. 3 shows those of (a) the cœnenchyma near the base, (b) the cœnenchyma near the tip.

The following is a list of the chief types with their measurements (length by breadth in millimetres):

I. Cœnenchyma:

1. Spindles, very thick with close-set warts. ( $0.046 \times 0.019$ ;  $0.046 \times 0.015$ ;  $0.042 \times 0.019$ .)
2. Short, stumpy spindles, densely warted. ( $0.027 \times 0.019$ ;  $0.027 \times 0.015$ ;  $0.023 \times 0.015$ .)
3. Almost spherical warty forms. ( $0.019 \times 0.019$ ;  $0.015 \times 0.015$ ;  $0.012 \times 0.012$ .)

II. Polyps:

1. Long thick spindles, with fewer and longer warts than in (a) of the cœnenchyma. ( $0.053 \times 0.012$ ;  $0.046 \times 0.015$ .)
2. Spindles with very few long warts. ( $0.042 \times 0.011$ ;  $0.038 \times 0.015$ .)
3. Spindles, still shorter, and with fewer warts. ( $0.031 \times 0.015$ ;  $0.027 \times 0.012$ .)
4. Flat, irregular scales from the verrucæ. ( $0.034 \times 0.015$ ;  $0.031 \times 0.011$ .)
5. Crosses. ( $0.038 \times 0.019$ ;  $0.031 \times 0.031$ .)

*Locality*:—Cape Morgan, N.N.E.  $9\frac{1}{2}$  miles; depth, 47 fathoms; bottom, broken shells (25. vii. 01). Previously recorded from Cape Morgan,  $32^{\circ} 45' 45''$  S.,  $28^{\circ} 26' 15''$  E.; 36 fathoms; stones (12. i. 01).

*Hicksonella flagellata* sp. n. Plate XIII. figs. 4, 5.

To this new species we refer two small complete specimens and a portion of a much larger specimen from the Cape. The longer complete colony is 20 cm. in length and the shorter is 12 cm., while the length of the broken portion is also 20 cm. The first specimen has a maximum breadth of 2 mm.; the second is about the same size; the fragment is 3 mm. in breadth.

The cœnenchyma is extremely thin in all the specimens, and in the non-polyp-bearing part the dark axis is easily seen through it. It is densely spiculate and extremely brittle, especially when dry. The surface is very arenaceous in appearance.

The axis is comparatively soft; it is composed of concentric laminae, which consist of a horny substance in which calcareous matter is deposited.

From end to end of the colony there runs a streak devoid of polyps and occupying about one-third of the circumference of the stem. The polyps occur densely packed on the remainder of the circumference; these project laterally and so add to the breadth of

the colony. Towards the base the polyps diminish in number while on the basal 4 or 5 cm. they are altogether absent. No definite arrangement is discernible, and young polyps occur scattered amongst the older forms.

The verrucæ are elongated and club-shaped (pl. XIII. fig. 4a); they are about 1.5 mm. in length and about 0.5 mm. in diameter near the apex. They are not retractile into the coenenchyma, and the swollen terminal part is due to the withdrawal of the anthocodia within the verruca. They are densely spiculate, and the scales on the aboral surface of the tentacles form a pseudo-operculum to the partially retracted anthocodia. Fig. 4b shows the characteristic appearance of the portion figured in 4a from the non-polyp-bearing aspect.

The spicules (pl. XIII. fig. 5) of this species are very characteristic. The following are some of the chief types, with measurements, length by breadth, in millimetres:—

1. Thick, massive, warty spindles. ( $0.053 \times 0.015$ ;  $0.049 \times 0.011$ ;  $0.038 \times 0.015$ ;  $0.038 \times 0.011$ .)
2. Smaller; usually curved spindles with the warts more developed on the convex side. ( $0.046 \times 0.008$ ;  $0.031 \times 0.008$ .)
3. Irregular scales (from the verrucæ). ( $0.031 \times 0.011$ ;  $0.027 \times 0.015$ .)
4. Aberrant type, resembling crosses. ( $0.034 \times 0.023$ .)
5. Peculiar, bilaterally symmetrical type with a sort of thick foliaceous expansion. ( $0.015 \times 0.015$ ;  $0.015 \times 0.011$ ;  $0.011 \times 0.011$ .)
6. Birotate forms (like those in *Subergorgia verriculata*). ( $0.011 \times 0.008$ ;  $0.008 \times 0.008$ .)

*Locality*:—Cape Morgan, N.  $\frac{1}{2}$  W., 10 $\frac{1}{2}$  miles; depth, 77 fathoms. By dredge. Rocks and broken shells (26. vii. 1901).

*Hicksonella capensis* sp. n. Plate XIII. figs. 6, 7.

This species has been established to include a very characteristic colony 75 cm. in length without the basal portion. The diameter at the present base is 3.5 mm.; midway it is 3.25 mm., while near the tip it is 3 mm., so that the tapering is very slight. The actual tip is conical.

The colony is twisted in an irregular open spiral throughout its entire length, but in such a way that the bare tract is always to the inside.

The coenenchyma is extremely thin and is densely spiculate. The axis is composed of concentric laminae, which consist of a horny substance impregnated with some form of calcareous matter. It is very hard, white in colour, and the surface is marked by deep longitudinal furrows. It tapers to a hair-like fineness at the tip.

The polyps are disposed over about three-fourths of the surface of the colony, leaving a bare longitudinal track which is very marked in the lower part, but almost disappears in the upper portion. The verrucæ are small, elongated and slightly club-shaped; they are about 2.5 mm. long and 0.25 mm. in diameter, and are much more openly disposed than in the other species (pl. XIII. fig. 6a). Fig. 6b shows the appearance from the non-polyp-bearing aspect. The tentacles are first infolded and then withdrawn into the upper part of the verrucæ, but the verrucæ themselves are not retractile into the cœnenchyma. The colour of the cœnenchyma is orange-red, but the verrucæ are almost white.

The spicules of this species are extremely irregular in form, but the following types may be distinguished (pl. XIII. fig. 7):—

1. Short slightly warty spindles. ( $0.07 \times 0.015$ .)
2. Spindles longer and more warty. ( $0.09 \times 0.038$ ;  $0.08 \times 0.038$ .)
3. Spindles still longer and more warty. ( $0.13 \times 0.05$ ;  $0.14 \times 0.046$ ;  $0.16 \times 0.065$ ;  $0.2 \times 0.06$ .)
4. Very irregular forms (probably developed from [3]). ( $0.17 \times 0.11$ ;  $0.16 \times 0.13$ .)
5. Flat, irregular scales. ( $0.14 \times 0.09$ .)
6. Thick, warty, almost spherical forms. ( $0.06 \times 0.045$ ;  $0.053 \times 0.034$ .)
7. Crosses (aberrant). ( $0.12 \times 0.11$ .)

*Locality*:—Red Cliff, S. of Morewood Cave, N.W.  $\frac{3}{4}$  N.  $6\frac{1}{2}$  miles. Natal. Depth, 37 fathoms; bottom, sand and shells.

#### *Position of Hicksonella.*

In this connexion the axis stands first to be considered. As will be seen from the descriptions of the various species, it is composed of concentric laminae; these laminae consist of a horny substance containing some form of calcareous deposit. It has been impossible so far to determine the nature of this limy deposit, but it is hoped that some solvent may be found to decompose the organic matter, and so enable a microscopic examination of the inorganic residue to be made. Until this is done, however, determination based on axial structure is impossible. We have, however, in our Revision of the Juncellids, discussed the possible affinities of several other specimens whose axis is similar to the one under consideration, and the resemblance strongly suggests that the present specimens approach closely to the Gorgonellidæ, to which family we would therefore temporarily assign them.

In the work cited above, after an exhaustive examination of a very large number of Juncellids, we suggested an emended classification, and included in the genus *Juncella* only those species whose spicules contained the type known as "clubs." This type of spicule

was first described and figured by Kölliker in his *Icones Histologicae*, p. 140, taf. xviii, fig. 46. In the Revision of the Juncellid-group of the Gorgonellidae several figures of this type of spicules are given (fig. 4, *a-g*).

The general form approaches that of the well-known "Indian club;" there is a distinct smooth median part or handle, which is surmounted by a few spines. The club-part also bears spines, and the most important characteristic is the fact that these spines are all directed away from the shaft, and do not arise perpendicularly.

Some doubt seems to have arisen since the time of Kölliker as to the exact nature of the "club," and this dubiety accounts for the original inclusion of the species *spiralis* in the genus *Juncella*. Hickson (op. cit.) describes a form of spicules as a club (pl. viii, fig. 8), but it is a club essentially different from Kölliker's type.

The spiculation as a whole is quite unlike that of any species of *Juncella* (op. cit., figs. 14, 23, and 26), so that it is impossible to refer the present specimens to that genus. They are even further removed from *Scirpearia* and *Nicella*, so that it seems necessary to form a new genus to include them.

#### *Diagnosis of Hicksonella, g. n.*

Colony simple, flagelliform, and generally twisted in a more or less open spiral at least in the older colonies. The axis consists of concentric laminae which are composed of a horny substance impregnated with some form of calcareous matter. It is generally hard, and the surface is marked by longitudinal ridges and furrows.

The cœnenchyma is extremely thin and densely spiculose; it is very brittle, especially when dry. The polyps are disposed in a broad longitudinal band; this leaves a narrow bare strip which traverses the whole length of the colony. The verrucae are not retractile into the cœnenchyma, and are elongated, slender and slightly club-shaped in the upper portion; they are covered with minute spicules, which appear like overlapping scales; the spicules on the aboral surface of the tentacles form a sort of pseudo-operculum to the partially retracted anthocodia.

The spicules vary in the different species, but the following are the chief types:—(1) Irregularly warted spindles; (2) flat, smooth, or slightly warty scales; (3) large irregular forms; (4) crosses; and (5) bi-rotate forms.

#### SPECIFIC DIAGNOSES.

*Hicksonella spiralis* (Hickson) = *Juncella spiralis* Hickson.

Colony unbranched; in the larger forms spirally twisted. The cœnenchyma is thin and densely packed with scale-like spicules; the axis is composed of concentric laminae of a horny substance.

in which a calcareous deposit is embedded. The polyps are restricted to a region occupying two-thirds to three-fourths of the circumference of the cœnenchyma; a longitudinal bare tract occupies the remaining part. The verrucæ are long and club-shaped, and are evidently not retractile into the cœnenchyma; they are closely packed together, and are covered with minute overlapping, scale-like spicules. The flat thin scales on the aboral surface of the tentacles forms a sort of pseudo-operculum to the partially retracted polyp.

The chief types of spicules are (1) in the cœnenchyma very thick spindles with close-set irregular warts, passing by gradual transitions to almost spherical warty forms; (2) in the polyps (*a*) long thick spindles with few long warts; (*b*) irregular forms and crosses; (*c*) small flat thin scales.

*Hicksonella flagellata* sp. n.

Elongated filiform colonies which, at any rate in the younger specimens, have only a trace of a very open spiral structure. The cœnenchyma is extremely thin and densely spiculose. The axis is horny and calcareous, and is composed of concentric laminæ. The polyps are confined to a broad longitudinal band occupying about two-thirds of the circumference. The verrucæ are elongated and club-shaped, and are not retractile into the cœnenchyma. The spicules are exceedingly minute, and very characteristic. They consist for the most part of (1) thick massive, warty spindles; (2) peculiar, bilaterally symmetrical forms, with a sort of thick foliaceous expansion; (3) bi-rotate forms (like those in the *Suberogorgia verriculata*); and (4) scales.

*Hicksonella capensis* sp. n.

Colony elongate, simple, and irregularly twisted in a spiral manner. The cœnenchyma is thin, and very spiculose. The axis is composed of concentric horny and calcareous laminæ. The polyps are disposed in a broad longitudinal band; they are very long, slender, and slightly club-shaped; they are covered with small spicules transversely arranged, and are not retractile into the cœnenchyma. The spicules consist of (*a*) short, slightly warty spindles; (*b*) longer, and more warty spindles; (*c*) irregular forms; (*d*) flat, irregular scales; and (*e*) crosses.

*Distribution*.—(1) Geographical. All three species were found off the east coast of South Africa, and therefore their inclusion in the Family Gorgonellidæ does not extend the distribution of that family.

*H. spiralis*. Off Cape Morgan.

*H. flagellata*. Off Cape Morgan.

*H. capensis*. Red Cliff, south of Morewood Cave, Natal.

(2) Bathymetrical. This genus, like other Gorgonellids, is represented by shallow-water forms; *H. spiralis* was dredged in 36 and 47 fathoms, and *H. capensis* in 37 fathoms.

#### NOTE ON THE GENUS.

Before leaving *Hicksonella*, however, it may be of interest to consider some of the more characteristic features, for example: (1) the distribution of the verrucæ, and (2) the spiral form. Professor Hickson (ii. p. 232), has drawn attention to these, and has put forward several suggestions as to their possible origin, so that, before taking each in detail, we shall quote his observations in full, and so obviate any possibility of misinterpretation which might result from detached references.

"This bare track, i.e. the part devoid of polyps, is seen in some other species of *Juncella*. In the description of *J. juncea*, from the Isle of Bourbon, Milne-Edwards and Haime state that the calices leave some trace of a median cœnenchymatous space. Ridley also states that there is a distinct groove in the specimen of *J. juncea* obtained by the 'Alert.'

The squamate armature of the verrucæ shows some affinities with the characters of the Primnoidæ, but, as the plate-like spicules are so small and there are no definite opercular plates, its affinities with *Juncella* are closer. It is noteworthy, however, that in the Primnoine genus *Calypterinus* the calices do not occur on one side of the stock. The track which is free from the calices in *Calypterinus*, however, is covered by the overlapping scales of the lateral calices so as to form a tube. These bare tracks on one side of the stock in *Juncella spiralis* and *Calypterinus allmani* have a certain resemblance to the bare tracks on one side of the smaller branches of some forms of *Solenocaulon*, and suggest the presence of symbiotic Crustacea. There is no evidence in support of this at present, but it would be worth the trouble of any naturalist, who has the opportunity of dredging in these waters, to note the character of any Alpheidæ or other animals that might possibly live with this *Juncella*. Dr. Gilchrist's note that nothing was found around which the stock twisted, is of the nature of a support for the suggestion that the spiral form of the larger stocks is associated with the presence of some epizoid animal. We may, for the present, regard the spiral form and the bare track as characters of the species, but if they prove to be mere adaptations to an epizoid animal their importance must be considerably discounted."

The question of the nature of the bare tract is of more than passing importance, for if, as Professor Hickson suggests, it is due to some epizoid animal, it must be discounted in any question of a taxonomic nature. A study of the species which he has named along with some others of a similar character, may, however, help

to suggest another possible explanation. For this purpose let us consider the following species:—

1. *Juncella juncea*.
2. *Scirpearia flagellum*.
3. *Suberogorgia köllikeri*.
4. *Lophogorgia lutkeni*.
5. *Juncella trilineata*.
6. *Scirpearia quadrilineata*.
7. *Calypterinus allmani*.

*Juncella juncea* and *Scirpearia flagellum*, in common with all other Juncellids, except *Juncella trilineata* and *Scirpearia quadrilineata*, have the polyps disposed in two longitudinal series separated by two diametrically opposite longitudinal bare tracts.

In *Suberogorgia köllikeri* the polyps arise from all parts of the stem and branches, with the exception of a narrow, often wavy, portion on either side of the cylindrical axis.

In *Lophogorgia lutkeni* the polyps are numerous and occur on both sides of the stem and branches; the central portion of both the main stem and branches on both surfaces are destitute of polyps.

Again, the stem and branches are flattened in the plane of branching and are marked on the flat sides by a narrow winding groove or furrow, which is continued along the flattened surfaces of the secondary branches. The polyp-bearing surface is divided into two lateral bands by means of the two grooves.

In *Juncella trilineata* polyps arise in three different bands, leaving three narrow bare strips, each of which has in its centre a slight rib or keel.

In *Scirpearia quadrilineata* the polyps are grouped in four definite longitudinal series separated by four bare spaces.

In *Calypterinus allmani* there is a bare tract on one side of the colony, otherwise the polyps occur all round.

In *Hicksonella* the verrucæ are all prominent, and arranged irregularly on two-thirds of the circumference of the stock, leaving a bare tract on one side free from verrucæ for the whole length of the stock.

A detailed discussion of the question under consideration with regard to the various species of Juncellids has been given in the "Revision of the Gorgonellids," so that it is only necessary here to recapitulate the conclusions which have been there stated.

1. In all species of Juncellids, so far known, the polyps are disposed in a certain number—two, three or four longitudinal series which are separated by a similar number of bare tracts. This number is constant for the species.

2. There is always a definite number of nutrient canals larger than the others, which are known as the main longitudinal canals.

3. These main canals always correspond in number and position to the bare tracts.

In *Suberogorgia köllikeri*, also, the longitudinal bare strips denote the position of the two longitudinal canals much larger than the others. The same holds true in the case of *Lophogorgia lutkeni*.

In all the species so far described the coenenchyma is moderately thick, and it has been possible to verify these points by means of transverse sections, but unfortunately the extreme thinness and the densely spiculate nature of the coenenchyma in *Calypterinus allmani* and *Hicksonella* have rendered it impossible to determine, so far, whether any main longitudinal nutrient canals exist. Is it not possible, however, that in these species, as in the others cited, the occurrence of a bare tract throughout the entire length of the colony may be an outward manifestation of internal morphological structure, and that it corresponds to the position of a single main longitudinal nutrient canal?

If this be so, there exists in Juncellids a complete series from one to four main canals, thus:

- |                                      |                    |
|--------------------------------------|--------------------|
| 1. <i>Hicksonella</i> sp. . . .      | One main canal.    |
| 2. <i>Juncella juncea</i> , etc. . . | Two main canals.   |
| 3. <i>Juncella trilineata</i> . .    | Three main canals. |
| 4. <i>Scirpearia quadrilineata</i> . | Four main canals.  |

Other features, however, seem to point to the unilateral symmetry being of morphological and not of mechanical origin. And in this connexion the spiral nature of the colonies must be considered. It will be seen from the descriptions of the three species given in this paper that two of these are spirally twisted, and also that the spiral arrangement does not commence at the very base, but at a considerable distance from it. In the third species the colonies are all small, and it is possible that they, later on, might have developed the spiral form.

An analogous case is seen in several Antipatharia in which the polyps have morphologically a unilateral disposition. In the waters around the Mergui Archipelago and also on the reefs on the East Coast of Africa, we have had occasion to examine a large number of spirally twisted colonies, and in no case was any form of support found. Now in the majority of these cases and also in the larger colony of *Hicksonella spiralis* examined, if any rigid support existed it must also have been spirally twisted, as will be evident from fig. 1, so that it is extremely improbable that these specimens could have been detached from such a support before being brought to the surface of the water. Even if that were possible and had actually happened, it would, of necessity, have caused considerable damage to the colony. No such evidence of fracture is to be seen on any specimen.

On the other hand it is difficult to imagine how the spiral effect could be produced by free living animals, such as Crustaceans,

when we take into consideration the enormous differences in the sizes of the spirals as seen in *Hicksonella spiralis* and *Hicksonella capensis*.

If then, the morphological origin of the unilateral disposition of the polyps be admitted as possible, an explanation of the spiral form assumed by such simple Alcyonaria and Antipatharia may exist on this basis. In colonial Cœlenterates the rate of growth in the region of the polyps is always far in excess of that in the non-polyp-bearing cœnenchymatous portion. This, in part, accounts for the flabellate colonies so often met with in Alcyonaria, but completely explains the flattening of branches of species with bilaterally disposed polyps. On the other hand, in large bushy Alcyonaria and Antipatharia it is always found that the polyps are directed outwards, so that the unilateral growth finds expression in all directions. In other words, the effect of the unilateral growth in one series of branches is neutralized by that in other series of branches growing in opposite directions.

Let us now consider the case of simple colonies.

1. In those whose polyps are disposed in four series, the growth is in four directions in two planes at right angles to one another, e.g. *Scirpearia quadrilineata*, and these consequently neutralize one another.

2. In *Juncella trilineata* the growth is in three directions, each of which encloses equal angles with the other. These also neutralize one another.

3. In other Juncellids the polyps arise in one plane, and are therefore situated diametrically opposite, and the colony is there still symmetrical.

4. If, however, the polyps all arise on one side, the growth is greater in that direction than in the other, and as the support in all these cases is originally central, this will naturally result in an overbalancing of the colony.

Is it not possible that, in maintaining symmetry in the colony, and also in endeavouring to expose the polyps equally to the food supply (a feature seen in all colonial organisms), this excessive growth might find expression in a spiral form (see pl. XIII. fig. 1)?

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Aberdeen University  
Studies : No. 48



## Zoological Studies

(Sixth Series)



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# VII.

## A REVISION OF THE GORGONELLIDAE: 1. THE JUNCCELLID GROUP.

By JAMES J. SIMPSON, M.A., B.Sc.,  
Carnegie Research Fellow, Zoological Department, University of Aberdeen.

### PLATES I-XIX.

[Read FEBRUARY 28. Ordered for Publication MARCH 2. Published AUGUST 19, 1910.]

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### I.—INTRODUCTION.

SYSTEMATIC description of Alcyonarians is beset with many difficulties, sometimes due to our ignorance of intimate structure—as in the case of the

genus *Telesto*, which Prof. Bourne (1, p. 29) refers to the *Steleckotokea*, but which Prof. Hickson (XII A, p. 348) considers should be placed in the *Alcyonacea*—and sometimes to the large number of forms separated by minute and very variable characters, as in the case of *Dendronephthya*. These difficulties are sometimes increased by the inadequacy of the diagnostic descriptions given in previous records. This may be illustrated, possibly with some useful result, by a consideration of the Gorgonellid genera *Juncella*, *Ellisella*, *Scirpearia*, *Scirpearella*, *Ctenocella*, and *Nicella*. These may be briefly included in the term “the Juncellid-group” of the Gorgonellidae.

My attention was first drawn to this group in 1905, while assisting Prof. J. Arthur Thomson in classifying some Indian Ocean Alcyonaria. The Indian Museum deep-sea collection contained a large number of these forms, as also did the collection made by Prof. Herdman in the Ceylon seas. Owing to the unsatisfactory nature of the classification of the group, and also owing to the extreme fertility of variation which occurs not only in different colonies, but even in different parts of the same colony, Prof. Thomson, in reporting on these collections, decided to give descriptions of most of the specimens, but refrained from naming any but undoubted species. The following note from the latter report sums up the situation:—“It may seem of little service to suggest problematical species based on a study of fragments; but, as we have given some description of each, our procedure is probably preferable to that of some other students of Alcyonacea, who have given names nude of any description. Our impression is that the elongated forms of *Scirpearella*, *Juncella*, and the like, so monotonous in general appearance, so perplexingly different when one gets beneath the surface, are subject to great variability.”

Ridley, in his “Report on the Alcyoniid and Gorgoniid Alcyonaria of the Mergui Archipelago” (Journ. Linn. Soc., vol. xxi., 1888), says, with regard to *Juncella*:—

“This is a most difficult genus. Looking at the variations in the external form and in spicules of the specimens here referred to this genus, and comparing them with facts previously known about it, one is struck by the extremely slight nature of the points separating some of the species. Had not *Juncella juncea* and *Juncella fragilis* been simple, while the present specimens of *Juncella gemmacea* are branched, it would have been difficult to distinguish the three species, as in spiculation every fresh specimen appears to present some slight difference; while the total differences of spiculation in these species are slight, and thus admit of little specific distinction. Then again *Juncella gemmacea*, though commonly branched, may be simple. Colour,

too, appears to afford little help in the determination of species. The form, size, and distribution of the zooid-verrucae, and the proportions of the corallum as a whole, seem to be the best points to rely upon. *Juncella elongata*, however, seems to be distinct in spiculation."

In reporting on the Littoral Alcyonaria of the Indian Ocean (Thomson and Simpson, 1909), we drew up a comparative table of all the specimens in this group which could not with certainty be referred to unquestionable species.

These specimens, along with those of other collections on which Prof. Thomson has reported, have been kindly handed to me as a basis for this memoir.

Since 1905, however, it has been my privilege to do some biological work on board the Royal Indian Marine Survey ship "Investigator"; and during that time I had an opportunity of collecting and observing a very large number of specimens belonging to this group in the waters around the Mergui Archipelago—a happy hunting-ground for Juncellids. By this means an extended study of variability was rendered practicable in a way which would otherwise have been impossible; and this has been of immense value in generic and specific determination.

The writer has also been fortunate in visiting a number of museums in which old specimens are deposited, and there examining these forms; while others, more inaccessible, have been kindly lent for examination.

The following list gives the more important collections in which specimens of this group occur, all of which have been systematically examined in the preparation of this report.

## II.—MATERIAL EXAMINED FOR THIS MEMOIR.

1. The Hunterian Collection of Gorgonellids in the Museum of the Royal College of Surgeons, London. This is a very old collection, and contains many interesting specimens which were of great use in determining the nature of the spiculation in some of the older species whose descriptions dealt entirely with macroscopical characters.

2. The Gorgonellid specimens in the collection of the Natural History Section of the British Museum, which include (1) most of the specimens on which the voluminous work of Gray was based, (2) the specimens of the "Alert" collections, and (3) the type-specimens of the "Challenger" expedition.

3. The collection made by Professor Herdman in the Ceylon seas (1902), described in the Ceylon Pearl Oyster Report (Roy. Soc.), and now deposited in the British Museum.

4. The specimens collected around the Cape of Good Hope and in the possession of the Cape Museum. These were reported upon in the "Marine Investigations in S. Africa."

5. The collection made by Mr. J. Stanley Gardiner in the Maldive Seas in 1900, and described in the "Fauna and Geography of the Maldive and Laccadive Archipelagoes."

6. The deep-sea collection, deposited in the Indian Museum, Calcutta, made during the different cruises of the Royal Indian Marine Survey ship "Investigator" in the Indian Ocean, and reported on in a Memoir published by the trustees of the Indian Museum.

7. The Littoral Collection made by the "Investigator," deposited and published as above. Very few of these specimens, however, received specific determination in that report, but they are fully dealt with in this memoir.

8. The "Wood-Mason Collection," made by Mr. J. Wood-Mason in the Indian Ocean. Some of these are described along with the Indian Museum Littoral Collection; but most of them were left over for incorporation in this memoir, and are here identified and described for the first time.

9. The collection made by "S. A. S. le Prince de Monaco," on the yacht "Hirondelle," during 1900-1902.

The type-specimens of this collection are deposited in the Oceanographical Museum at Monaco.

10. The collection made by Mr. J. Stanley Gardiner in the Indian Ocean around the Maldive Islands, and reported on in the Transactions of the Linnean Society (1910).

11. A partly undescribed collection made around the Cape of Good Hope and in the possession of the Cape Museum.

12. Specimens collected at Naples by Professor Thomson, and handed to me for identification. These are dealt with in this memoir, and are deposited in Aberdeen University.

13. The "Mergui Collection," made by the writer in the waters around the Mergui Archipelego, Burma, in 1897. These are here described for the first time; and the type-specimens are deposited in the Natural History Museum of Aberdeen University.

I am pleased to have this opportunity of expressing my thanks to all those who have so generously placed specimens at my disposal; for only through their kindness has it been possible to render this study in any way complete. I am specially indebted to Professor F. Jeffrey Bell, of the British Museum, for the facilities he provided me in examining the magnificent collection in that institution; to Dr. Burne, of the Royal College of Surgeons,

London, for an excellent sketch of a colony in that museum (fig. 46); to Professor Sydney J. Hickson, Manchester, for kindly sending me portions of the specimens and also the preparations of spicules on which the descriptions given in his memoirs are based; but most of all to Professor J. Arthur Thomson, who has entrusted the greater part of the new material to me for identification, including the collection of the Indian Museum, Calcutta, the Monaco collection, and the Cape collection referred to above. I cannot sufficiently express my thanks to him for placing his splendid series of Aleyonarian literature at my disposal, for the personal interest he has taken in the work, and for much kindly criticism and advice.

I must also thank the Trustees of the Carnegie Trust for a grant towards defraying the cost of illustration, and also the two artists, Mr. George Davidson and Mr. William Smith, for the trouble they have taken in preparing the drawings.

### III. BIOLOGICAL NOTE.

The Juncellid-group of Gorgonellids are typically shallow-water forms, and occur both in tropical and temperate seas, chiefly, however, in tropical waters, but have not so far been found in Arctic or Antarctic seas. They are usually found within the hundred-fathom line, and exist in very shallow water. On the coral reefs of the Mergui Archipelago, numerous colonies may be seen swaying to and fro in the air when uncovered by the water at low tide. This power to survive the heat of the sun in the tropics for as much as two hours daily is proof of great vitality in the group.

The colonies may be simple or branched, and when simple may attain to great lengths; specimens of over six feet long are not infrequent. This great length is all the more remarkable when it is remembered that there is no jointing of any sort, as is seen in *Isis*, *Melitodes*, and the like. They are extremely flexible, sway to and fro in the ocean, and when living may be bent into the form of a figure 8 without the least chance of fracture. This is of great morphological significance, and is paralleled in the animal kingdom only by (1) Pennatulids (e.g. *Umbellula*), (2) Antipatharians, and (3) Nemerteans.

Nemerteans, however, live a free existence; *Umbellula* is also free, and lives embedded in mud at great depths. The analogy, therefore, restricts itself to Juncellids and Antipatharians. In the former the axis contains lime; in the latter it is composed entirely of a horny substance.

The proportion of coenenchyma to axis is very different, however, in the two cases. In the former the coenenchyma preponderates over the axis, but in the latter the reverse holds true.

The extraordinary power of regeneration as seen in this group is of great physiological interest. Normally they are attached to rocks or corals; but even shells—e.g., *Margaritifera margaritifera*—may form a basis of support. Ridley records the case of a colony in the "Alert" Collection which had been broken from its attachment, and in which the coenenchyma had quite overgrown the fractured part, which had continued its existence as a free colony, floating in the ocean. A similar case has been recorded by the writer for *Isis hippuris* (Journ. Linn. Soc. Zool., vol. xxxvii., pp. 421-433, pl. 43).

These large Juncellid colonies also form bases of attachment for numerous kinds of animals. Ophiuroids and crinoids are constantly found attached to them, but equally common and more permanent are acorn-shells and bivalves. The former settle down in the larval stage, bore their way through the coenenchyma, and remain attached for life to the axis. The Alcyonarian colony responds to the stimulus, and continues to develop coenenchyma at the fractured part, so that eventually the acorn-shell is quite overgrown by polyp-bearing coenenchyma, leaving only a small oval aperture, by means of which the acorn-shell derives its food—a characteristic form of commensalism.

Of more economic interest, however, is the case of *Pteria macroptera*, which is eagerly sought for on account of its pearl-bearing proclivities.

While examining the marine fauna of the Mergui Archipelago, one of the most striking phenomena encountered was the fact that on nearly every colony of *Juncella gemmacea* obtained there were abundant specimens of this oyster. Some idea of the strength of these colonies may be gathered from the fact that on one individual colony there were over a hundred oysters. The greater number of these were almost full-grown, and each of them weighed on an average more than the colony itself. The byssus was usually overgrown by coenenchyma; but the great rate of growth of the shell itself precluded the possibility of the Alcyonarian keeping pace with it.

*Reproduction.*—A large proportion of the colonies examined contained enormous spherical reproductive bodies. Serial sections of some of these were made; and Professor Hickson also kindly sent me some sections prepared by him. These bodies consisted of two kinds:—

(1) Ova with a large nucleus and a distinct nucleolus almost identical with the figures given by von Koch.

(2) Spermathecae or sperm sacs in which it was possible to trace spermatogenesis almost up to the stage of fully formed spermatozoa.

No trace of segmentation of ova was discernible; and it is more than probable that this does not take place within the parent body.

It is also worthy of note that the ova and spermathecae occurred in

different specimens, so that it is almost certain that in this group the colonies are dioecious.

#### IV.—HISTORICAL SUMMARY OF THE GROUP.

##### Family **GORGONELLIDAE.**

The family Gorgonellidae is here regarded, on the whole, in the sense of Wright and Studer (L, p. lxiv), who, accepting Kölliker's diagnosis, define it in the following terms:—

"In the species of this family the coenenchyma is thin, smooth on the surface, with small spicules in the form of warty double-clubs and stellate forms. The polyps have more or less well-developed verrucae and are usually biradially disposed. The axis is lamellar and calcareous, but retains its shape after the extraction of the calcareous matter."

The colonies in the Gorgonellidae form simple or branched masses whose calcareous axis gives to the whole a rigid appearance. The branches and twigs are frequently flattened; and the polyps are either distributed in two rows on the edges thereof, or are so disposed in lateral bands that a free space is left in the middle, in which are to be found one or more longitudinal furrows. The longitudinal canals are partly of small diameter, partly large. Two usually occur on the surfaces of the stem which are destitute of polyps. On the surface of the coenenchyma in dried specimens their position is marked by longitudinal grooves.

It includes the following genera:—

NICELLA,	.	.	.	.	Gray.
SCIRPEARIA,	.	.	.	.	Cuvier, emend. Studer.
SCIRPEARELLA,	.	.	.	.	Wright and Studer.
JUNCELLA, <sup>1</sup>	.	.	.	.	Valenciennes, emend. Studer.
ELLISELLA,	.	.	.	.	Gray, emend. Studer.
VERRUCELLA,	.	.	.	.	Milne-Edwards.
CTENOCELLA,	.	.	.	.	Valenciennes.
PHENILIA,	.	.	.	.	Gray.
HELANIA,	.	.	.	.	Gray.

The two genera *Phenilia* and *Helania* are only imperfectly known; and the diagnoses, as given by Gray, leave much to be desired. Studer considers *Phenilia* as synonymous with *Gorgonella*; and it is more than likely that *Helania* cannot now be considered as a distinct genus. The spicules of

<sup>1</sup> The original spelling of this genus was "*Junceella*," but it is now generally written "*Juncella*," so that, except in references, the more common spelling has been adopted in this report.

these two genera have never been investigated; and I have been unable to obtain an authentic specimen of either of these, so that, for the present, they must remain as problematical genera.

It is extremely doubtful whether *Verrucella* and *Gorgonella* can be regarded as distinct; but, in the present memoir, it is not proposed to deal with the various species which have, from time to time, been referred to them. At the same time it must be noted that a very fruitful study might be made with regard to these forms.

Excluding, then, *Phenilia*, *Heliania*, *Gorgonella*, and *Verrucella*, it might be of advantage, before proceeding to examine and differentiate the various genera and species, to trace briefly the different bases of classification which have from time to time been adopted in regard to the six genera under consideration.

The oldest of the genera under consideration is *Scirpearia*, which was established by Cuvier (*Règne Animal*, p. 319) in 1830. There is still doubt, however, as to the exact identity of Cuvier's species.

Wright and Studer (l., p. 154) give a detailed account of the history of the name *Scirpearia* from the time of Cuvier to the time of publication of the "Challenger" Report.

In 1855 Valenciennes (*Comptes Rendus*, xli., p. 14) established the family *Gorgonellaceae*, with the following diagnosis: "Axis effervescing with hydrochloric acid," to include two new genera, namely, *Juncella* and *Ctenocella*. He defined them thus:—

*JUNCELLA*—Stems straight, covered with polypiferous cells scattered upon the sclerobase.

*CTENOCELLA*—Sclerobase forming straight rods. pectinated only on one side of the principal stem.

In the former genus he recognized the following new species:—*J. juncea*, *J. surculus*, *J. rimen*, *J. elongata*, *J. calyculata*, and *J. hystrix*.

In the latter *C. pectinata*.

Two years later Gray (P.Z.S., 1857, p. 159) proposed to re-arrange these genera thus: "This genus (*Suberogoria*) and the genera *Juncella*, *Ctenocella*, and *Gorgonella* of Valenciennes should be arranged with *Corallium* under the family *Corallidae* characterized by having a calcareous axis." In the same year, however (P.Z.S., 1857, p. 287), he abolished the genus *Ctenocella*, divided up the genus *Juncella*, established the genus *Ellisella*, and gave the following diagnoses and sub-divisions to include one new and several previously described species:—

**ELLISELLA.**—Coral simple or furcately branched; branches subcylindrical, with a more or less distinct lateral groove, especially at the base. Axis continuous, opaque, solid, calcareous, hard at the base and softer above. Bark when dry, granular, thin, with numerous series of sunken or slightly prominent polypiferous cells on each edge of the stem and branches.

- (1) *E. juncea*, coral simple, sub-compressed beneath; *Juncella* Val.
- (2) *E. elongata*, coral furcately branched, branches sub-cylindrical.
- (3) *E. coccinea*, furcately branched, branches sub-cylindrical, very long, virgate.
- (4) *E. pectinata*, coral branched fan-like, branches with a series of virgate branches on the upper side only. (Ctenocella.)

He also revived the genus *Scirpearia* in the following terms:—Coral slender (simple or sub-simple), rod-like. Axis slender, cylindrical, hair-like, solid white, calcareous, attached by a broad base. Bark (when dry) thin, smooth, granular, with a series of sub-cylindrical polypiferous cells placed alternately on each side of the stem.

*S. mirabilis*.—Two years later (P. Z. S., 1859, pp. 479–486) he established the family Elliselladae, and gave the following diagnosis:—"The axis solid, calcareous, not jointed. Bark granular, cells on the sides of the stem and branches separated by a lateral groove." (α) Cell more or less elongate.

(1) **ELLISELLA.**

Coral tree-like, sub-cylindrical; branches free; cells numerous, small, crowded. *E. juncea*, *E. elongata*, *E. coccinea*, *E. pectinata*.

(2) **SCIRPEARIA.**

Coral simple or forked; cells sub-cylindrical in two alternate series.

*S. mirabilis*, coral simple.

*S. dichotoma*, coral branched, forked.

From this résumé it will be seen that, up to this time, identification was based on external characters alone; but in 1864 a great advance was made when Kölliker investigated the spicules, and defined *Juncella* as having "clubs, double-clubs, and double-stars. The spicules of the polyps are small spindles." He recognized the following three species:—

- (a) With clubs: *Juncella juncea*, *J. gemmacca*.
- (b) Without clubs: *J. elongata*.

Gray, however, seems to have been unacquainted with Kölliker's contribution, for in 1870 (Cat. Lith., B. M.), he, without taking into account the nature of the spiculation, overturned his previous classification; and in the

family Elliselladae placed Juncella, Ellisella, along with many others which do not concern us here; at the same time he re-established the genus Ctenocella, and formed a new one, viz., Viminella, in the same family.

The genus Scirpearia he relegated to a heterogeneous group, which he called the Caligorgiadae, in which he established the genus Nicella, to include his *Scirpearia dichotoma*. The following synopsis brings out the general plan in this classification:—

#### Family **ELLISELLADAE.**

**JUNCCELLA.**—Coral simple, sub-compressed near the base; branches sub-cylindrical, with a more or less distinct lateral groove, especially at the base. Axis continuous, opaque, solid, calcareous, hard at the base, white and softer above. Bark, when dry, granular, thin, with numerous series of sunken or slightly prominent polypiferous cells on each side of the stem and branches: *J. juncea*.

**ELLISELLA.**—Coral tree-like, furcately branched; branches spreading and then ascending; lateral groove very narrow, but well marked; the rest like Juncella: *E. elongata*; *E. coccinea*; *E. gemmacea*; *E. calyculata*.

**CTENOCELLA.**—Coral branched, fan-like, expanded in a plane; branches with a series of virgate branchlets on the upper side; lateral line well marked, but narrow: *C. pectinata*.

**VIMINELLA.**—Coral simple, elongate, flagelliform. Bark thin; lateral space broad, with a sunken line. Polyps-cells, cylindrical, prominent, in three or four series on each edge of the stem. Axis grey, calcareous:—

<i>V. juncea</i>	=	<i>J. vimen</i> .
<i>V. flagellum</i>	=	<i>J. extans</i> and <i>J. flagellum</i> .
<i>V. hystrix</i>	=	<i>J. hystrix</i> .
<i>V. laevis</i>	=	<i>J. laevis</i> .

#### Family **CALIGORGIADAE.**

**SCIRPEARIA.**—Coral slender (simple or sub-simple), rod-like. Axis slender, cylindrical, hair-like, solid, white, calcareous, attached by a broad base. Bark (when dry) thin, smooth, granular, with a series of sub-cylindrical, polypiferous cells placed alternately on each side of the stem. Lateral groove indistinct. *S. mirabilis*, *S. funiculina*, *S. barbadensis*, *S. monilliformis*.

**NICELLA.**—Coral fan-like, on one plane, branched; branches forked, rather diverging. Bark smooth, brown. Polyps-cells cylindrical, truncated, diverging from the stem at nearly right angles, mouth open. Axis calcareous, white, solid. *N. mauritiana*.

In 1878, Studer still further advanced K  lliker's contribution, and noted that when one investigated the spicules of the various species in the family, one found two definite groups:—

- (1) Those with an outer layer of *clubs* and an inner layer of *double-clubs* ;  
and
- (2) Those with only *double-clubs* and *spindles*.

The latter group he again sub-divided on the basis of the nature of the verrucae. His classification would appear thus:—

- (1) Spicules, clubs, and double-clubs, *Juncella*.
- (2) Spicules, double-clubs, and spindles—

A. Calyces not prominent, *Ellisella*.

B. Calyces markedly projecting, *Scirpearia*.

**JUNCCELLA.**—Colony simple or forked ; verrucae club-shaped, prominent or otherwise. In the coenenchyma, an outer layer of clubs and an inner layer of double-clubs. *J. juncea*, *J. gemmacea*, *J. flexilis* nov.

**ELLISELLA.**—Colony simple or forked. Verrucae hardly projecting, in two rows on the sides of the stem and branches. In the coenenchyma only double-clubs and spindles. *E. maculata* nov., *E. calamus* nov.

**SCIRPEARIA** (including *Nicella*, *Raynerella*, and *Viminella*).—Colony simple or branched. Axis cylindrical, calcareous, and horny. Coenenchyma thin, with prominent polyps, which are disposed in two rows on the sides of the stem and branches. Spicules, double-clubs, and spindles. *S. mirabilis*, *S. flagellum* (= *J. extans* and *V. flagellum*).

**NOTE.**—Studer includes in *Scirpearia* *Nicella mauritiana*, and says that the only type of spicule in this species is "spindles thickly covered with warts." Ridley, however, doubts whether the specimen examined by Studer was really *N. mauritiana*. This is extremely probable in view of the fact that *N. dichotoma* (which is a synonym of *N. mauritiana*) contains both double-clubs and spindles. (See subsequent discussion of this species.)

Wright and Studer (L.) united all these genera under the family Gorgonellidae, which they placed in the Holaxonia, near the Gorgonidae and Plexauridae. At the same time, they, while recognizing *Juncella*, *Nicella*, *Ctenocella*, *Scirpearia*, and *Ellisella*, established a new genus under the name of *Scirpearella*, which they defined thus:—"Colony simple or very feebly branched. Axis calcareous, brittle, smooth, or grooved. Polyps arranged in rows or spirals, retractile, with more or less prominent verrucae. The coenenchyma is moderately thick and finely granular. The spicules are spiny spindles and double-clubs."

The following species are described :—*S. monilliforme* nov., *S. profunda* nov., *S. gracilis* nov., *S. rubra* nov.

Hickson (xv, p. 819), in discussing this group, says that the four genera Juncella, Ellisella, Scirpearia, and Scirpearella are undoubtedly related. He takes exception, however, to the distinction between Juncella and Ellisella based on spicular characters, and proposes to unite them under the name Juncella. At the same time he refers the genera to two groups—

- (1) those with club-shaped spicules, and
- (2) those without club-shaped spicules.

On this system he gives the following arrangement of the species :—  
With clubs :—

*J. juncea* Pallas.  
*J. gemmacea* (Milne-Edwards).  
*J. flexilis* (Studer).  
*J. fragilis* (Ridley).  
*J. barbadensis* (Wright and Studer).

Without clubs :—

*J. elongata* (Valenciennes).  
*J. calamus* (Studer).  
*J. maculata* (Studer).  
*J. spiralis* Hickson.

He also makes the following note :—“*J. hepatica* (Kl.) may not be distinct; and *J. funiculina* (M. and D.) and *J. laevis* Verrill are not sufficiently well known to be classified in this system.”

The genera Scirpearia and Scirpearella he, however, retains as being capable of identification as follows :—

Scirpearia—prominent verrucae in two rows.

Scirpearella—prominent verrucae arranged in a spiral manner.

Before considering to what extent any or all of these systems of classification may be regarded as an aid to the determination of natural affinities, it will be well to review all the characters, macroscopic and microscopic, upon which stress has been laid, and also any others which might serve to elucidate the relationships existing in this group.

## V.—MACROSCOPIC AND MICROSCOPIC CHARACTERS AS A BASIS OF CLASSIFICATION.

## (1) COENENCHYMA.

(a) *Surface*.—The surface of the coenenchyma is generally smooth to the naked eye, but presents a glistening, arenaceous appearance when viewed with a lens. This is due to the small spicules, which project slightly, either singly or in small clusters.

*Thickness*.—The thickness varies in different species; e.g., in *Juncella juncea*,<sup>1</sup> *Juncella gemmacea*, and *Scirpearia furcata* it is usually thick; but in *Juncella racemosa*, *Scirpearia alba*, and *Scirpearia flagellum* it is generally thin.

On the other hand, however, extremes may be found in different specimens of the same species. No better example of this can be cited than *Juncella juncea* (see later). For this reason the thickness of the coenenchyma cannot be regarded as a specific criterion. It does, however, affect the general appearance of the colony, inasmuch as the verrucae are capable of greater retraction in those specimens in which the coenenchyma is above the average thickness. (See figs. 9 and 10 (*a*, *b*, and *c*) of *Juncella juncea*, fig. 100 of *Scirpearia andamanensis*, and figs. 83 and 88 of *Scirpearia furcata*.) As a contrast to these, figs. 49 and 56 of *Scirpearia flagellum* may be taken as typical. One very important feature in regard to the thickness of the coenenchyma is the fact that this is almost a constant in any one specimen; the difference in the thickness of the colony is really due to the axis.

It, therefore, follows that, although the thickness of the coenenchyma varies very little in any individual specimen, it may vary considerably in different specimens of the same species, and is therefore of little if any taxonomic value.

*Consistency*.—The coenenchyma is densely packed with minute spicules, and is consequently very granular and brittle, especially when dry. It presents a gritty, uneven surface when cut with a knife.

(b) *Histology*.—The coenenchyma is divided into an outer non-canal-bearing part in which the polyps are embedded, and an inner part in which small canals ramify in all directions (figs. 10 and 19). These are separated by a series of longitudinal canals, which are arranged peripherally. The proportionate thickness of these two parts varies greatly in different specimens, and is of no taxonomic value.

<sup>1</sup> The generic and specific names given in this part of the memoir are those which are adopted in the final classification (q.v.).

(c) *Colour*.—The colour of the colonies is due almost entirely to the pigment in the calcareous spicules, so that there is very little change after long preservation in spirit. The fleshy part of the coenenchyma is generally pinkish; but the loss of this, due to immersion in alcohol, is hardly perceptible in the final tint. It is worthy of note, however, that in white colonies the coenenchyma is almost transparent; and immersion in alcohol results only in rendering the colony more opaque. When dried, the colonies acquire a very dull opaque colour; but the warm tones, which are so characteristic of the group, may be restored on immersion in alcohol.

The colour of a colony is of no taxonomic importance, as this may vary in different specimens of the same species. Two very good examples of this are *Scirpearia flagellum* and *Scirpearia furcata*. A few notes on these two species may be of interest; but it is worthy of note that, without some definite and recognized colour-scheme, precise description of colour is impossible. The following colours are, however, given by the different authors. The exact specimens will be better recognized if given under the names by which they were originally described.

*Scirpearia furcata* (emend.).

- S. sp.?* Thomson and Henderson: "The general colour of the colony is reddish orange; but the verrucae are distinctly red."
- S. furcata* Hickson: "Orange red coenenchyma, with dark red dome-shaped verrucae."
- S. furcata* var. Hickson: "The colour is not so much a pure red, but tinged with orange."
- S. indica* Hickson: "The colour varies in different specimens. In one the coenenchyma is white; but the tips of the verrucae are red. In another the verrucae are white throughout; but there are streaks of pink along the coenenchyma, running irregularly and uniting at the base to give a general pale-red colour."
- S. sp. β.* Thomson and Henderson: "The general colour is pale salmon-pink; but the verrucae are white, and streaks of the same colour permeate the coenenchyma."
- J. elongata* Hickson: "The colour is pale pink, and the verrucae are white."
- Mergui specimen*: The colour is orange, but the anthocodiae are white.
- Type specimen (sens. emend.)*: "The colony is of a pale yellow colour, with red verrucae. Near the base long streaks of red extend longitudinally from the verrucae and interlock, giving a peculiar tessellated pattern."

In the Cape and Mergui Collections are a number of colonies: (1) creamy white, (2) pale orange, (3) bright orange, (4) dull orange red, (5) brick-red, (6) pale orange yellow, with reddish tips to the verrucae.

*Scirpearia flagellum.*

Monaco specimens: Dull white, creamy-white, pale yellow, orange yellow.

Naples specimen: The general colour of the colony is reddish orange, but the tips of the verrucae are distinctly more reddish.

On the whole, the colour schemes of Juncellids are defined by the coenenchyma proper and the verrucae, but in a few cases the colour of the verrucae extends in streaks along the coenenchyma, and gives very pretty tessellated patterns. Good examples of this are seen in some forms of *Scirpearia furcata* (*sens. emend.*) (see fig. 77).

(2) CANAL SYSTEMS.

This is a feature to which little or no attention has so far been paid, but which is of great taxonomic importance, and which also exerts a great influence on certain superficial appearances which have been used for specific diagnosis.

*Description.*—In all Juncellids it is essentially of the same type, and consists of (1) an inner longitudinal series separating the inner canal-bearing part of the coenenchyma from the axis, (2) an outer longitudinal series separating the two divisions of the coenenchyma (see above), and (3) a transverse series ramifying in all directions through the inner part of the coenenchyma and uniting the two longitudinal series.

This is common to all Juncellids (see figs. 10 and 13 of *Juncella juncea*, fig. 19 of *Juncella gemmacea*, fig. 25 of *J. trilincata*, fig. 114 of *Juncella quadrilincata*, and fig. 43 of *Scirpearia pectinata*).

As has been already remarked, the thickness of the coenenchyma is almost a constant, and consequent upon this the thickness of the canal-bearing parts separating these two series of canals is also a constant (see figs. 10, *a*, *b*, and *c*).

With regard to the longitudinal series, it is essential to note that the number varies in the different parts of the colony, or, in other words, diminishes from the base upwards.

We have made an extended study upon a large number of specimens, and the following observations may prove useful:—

1. The outer series of canals communicates directly with the polyps, and, by means of the transverse canals, communicates with the inner series.

2. The cause for the diminution in number is not far to seek. The number of polyps is smaller in the younger parts, and consequently the number of canals communicating with these is smaller.

3. The number of canals in the outer series bears no proportion to the number in the inner series in the different parts, although the number diminishes in both cases from the base upwards. It diminishes more rapidly in the inner series.

Let us consider the different series, and see to what extent these may be considered of taxonomic value.

1. *Transverse series*.—This series, as has been pointed out, serves to connect the outer longitudinal series with the inner longitudinal series, and, as might be expected, is of no specific importance.

2. *Outer longitudinal series*.—The canals of this series communicate directly with the polyps, are all of equal size, have no influence on external or internal form, are constant in all specimens, and cannot therefore be taken into account in specific determination.

3. *Inner longitudinal series*.—We have here to deal with a series which has the following characteristics:—

- (a) The canals are not all of equal value.
- (b) They exert an influence on the external form of the colony.
- (c) They produce an effect on the surface of the axis.

The superficial results produced by this series of canals have been used by different authors as a basis of classification; but no systematic examination has ever been attempted, nor has any causal explanation ever been given, so that it may serve some useful purpose to study the actual influence exerted and the constancy of the results.

Studer (xxxviii) in 1901 makes the following note:—"A transverse section of a colony of *Scirpearia flagellum* (Pl. IX, fig. 11) shows that the polyps arise on two sides of the axis; there are two large longitudinal canals in the plane perpendicular to that of the polyps."

Thomson and Henderson (xxxix), p. 315, in describing *Juncella trilineata* say:—"Polyps arise in three different bands, leaving three narrow bare strips, each of which has in its centre a slight rib or keel. Under each bare strip lies a large longitudinal canal. The axis shows longitudinal grooves."

These are practically the only two references to the phenomena under investigation.

Let us consider each in detail:—

(a) *The canals are not all of equal value*.—A transverse section of any Juncellid colony reveals the fact that there is a certain number of the

canals much larger than the others, and, no matter at what level the section be taken, this number is constant for the specimen (see figs. 80, 13, 19, 24, and 111). There is only one exception to this rule, namely, *Scirpearia pectinata* (fig. 43a); but in this case the conditions which occasion it are themselves exceptional, and will be described later. In the polyp-bearing branches the rule, however, holds good (fig. 43b and c).

In the great majority of cases the typical number is two—e.g. *J. juncea*, *J. gemmacea*; but in two colonies examined, viz., *Juncella trilineata* (Thomson and Henderson), and *Scirpearia quadrilineata* n. sp., there is a departure. In the former there are three and in the latter four (see figs. 25 and 111). These large main longitudinal canals are always symmetrically arranged, either

- (1) diametrically opposite (two) (fig. 10), or
- (2) at the ends of radii enclosing equal angles (three) (fig. 25), or
- (3) at the ends of two diameters at right angles to one another (four) (fig. 111).

(b) *They exert an influence on the external form of the colony:*—(1) A very characteristic feature of Juncellids is the fact that in nearly every colony examined there is a certain number of longitudinal tracts devoid of polyps. This may be very marked, as in the case of *Scirpearia flagellum*, *Scirpearia ceylonensis*, and *Juncella ramosa*, or less marked in, e.g., *Scirpearia verrucosa*. In all these the number is always two.

In *Juncella trilineata*, however, the number is three, and in *Scirpearia quadrilineata* the number is four.

(2) These longitudinal bare tracts are symmetrically disposed, and correspond in position to the internal large main canals. The presence therefore of a certain number of bare tracts, and the consequent grouping of the verrucae into a corresponding number of longitudinal series, are thus the outward manifestation of the internal structure as expressed in the inner series of longitudinal canals. These bare tracts are sometimes marked by a longitudinal ridge or depression; but this is due to the large canal being either distended or in a collapsed state.

Since this phenomenon is a constant for any individual specimen, it seems to us that it may with safety be considered of taxonomic importance.

(c) *They produce an effect on the surface of the axis.*—"The surface is marked by longitudinal striae"; "Ridges and furrows occur on the surface of the axis"; such statements enter into the description of a great number of specimens given by various authors. A close examination of a transverse

section reveals the fact that the furrows correspond in position to the canals of the inner longitudinal series.

Consequently, since the number of these canals diminishes from the base upwards, the number of ridges and furrows also diminishes, so that the actual number of furrows seen at any one level is not characteristic of the colony as a whole (see fig. 11*a*, *b*, and *c*). It is unfortunate, however, that several authors have used the number of furrows as a character on which to separate different forms; for it is at once evident that such diagnosis must be negatived.

In some cases—perhaps in all—although it is not very marked, two of the furrows are deeper than the others, and these correspond to the two large canals.

Thus, then, we see that the inner longitudinal series of canals has several well-defined characteristics, two, at any rate, of which may with safety be regarded as specific, namely:

(1) A certain number, constant for the specimen, are decidedly larger than the others.

(2) These large main canals determine the distribution of the verrucae, and manifest themselves externally by longitudinal bare tracts.

For these reasons we have decided to use this character as a basis for specific diagnosis.

### (3) POLYPS.

(*a*) *Structure*.—The polyps vary greatly in shape, not only in different specimens, but also in different parts of the same specimen. The structure is essentially simple; fig. 1 of *Scirpearia pectinata* may be taken as typical. (See also fig. 74 of *S. furcata*.) It consists of (1) the verruca, and (2) the anthocodia. There is no distinct point of demarcation between the two, but the one merges imperceptibly into the other. It may, however, be useful to distinguish between the lower cup-like portion, which may be termed the verruca, and the upper tentacle-bearing portion, the anthocodia.

The verruca arises from the general coenenchyma, but is supported by spicules of a different type, as will be explained further on; these have no definite arrangement. Near the summit there are usually eight triangular lobes or teeth which are also densely spiculose. From these arise the short, stumpy pinnate tentacles; these are usually very broad, conical in shape, and bear short, simple pinnules about six to ten in number.

The anthocodiae are usually white, no matter what may be the colour of the colony, and the tentacles bear a number of small, flat, scale-like spicules on the aboral surface. These are very easily overlooked in a preparation;

and in fact they are so similar in all species as to be of no specific importance, so that their inclusion in each individual description is hardly necessary.

(b) *Motility*.—To define the shape of the verrucae would be to describe the various phases through which it passes from complete expansion to extreme retraction. It may be well, however, to consider some of the phases presented in the same and different specimens, and note to what extent motility occurs. Fig. 32 of the Cape specimen of *Scirpearia flagellum* and fig. 64 of the type specimen of *Scirpearia alba* show the verrucae as low cones. Fig. 9a of *Juncella juncea*, and fig. 90a, b, and c of *Scirpearia furcata* show them as level with the coenenchyma, or even depressed beneath it.

On the other hand, however, the great majority of the figs.—e.g., 36, 44, 85, and 98—depict them as directed upwards, and adpressed to the coenenchyma.

When we examine these carefully, we find that the upper surface of the polyp is considerably wrinkled, while the lower is decidedly stretched. (See fig. 49 of the Naples specimen, and fig. 36 of the Cape specimen of *S. flagellum*.)

Another phase, however, presents itself. Fig. 2, from a specimen in the Monaco Collection, has been added to show a very peculiar disposition not uncommon in *Scirpearia flagellum*. This species is remarkable for the length of its verrucae, the thinness of the coenenchyma, and the consequent slight retraction of the former into the latter. In this figure the verrucae on one side of the stem are all directed upwards, while on the other they are all directed downwards. In other specimens some are directed upwards, some horizontally, and some downwards, while a very peculiar arrangement is seen in the Naples specimen described in this report. The colony has been broken in two and preserved in this state. In the upper part of the colony the polyps are nearly all directed upwards, while in the lower part they are nearly all directed downwards.

Now it is highly improbable that this state of affairs could have existed while the colony was living in the sea; so that it is not pushing a speculation too far to conclude that the position in which the colony was immersed in alcohol, for killing and preservation, has determined to some extent the direction in which the polyps have retracted. In fact, the probability is that the polyps naturally grow horizontally, but have a power of rotation through  $180^\circ$  both horizontally and vertically, or, in other words, the oral aperture can take up any position on the surface of a hemisphere whose radius is the length of the verruca. The mode in which these colonies obtain their food, and the different positions which they must assume when swayed by currents, are strongly in favour of such an argument.

(c) *Retraction*.—That the polyps are capable of great retraction is a fact which is of the utmost importance in specific determination. The manner in which this is accomplished is very simple. The tentacles are first infolded, the eight lobes of the verruca close over them, and then the whole is withdrawn into the coenenchyma. The longitudinal section (fig. 53) of *Scirpearia flagellum* shows the attachment of the strong retractor muscles which accomplish this; and fig. 10 of *Juncella juncea* shows the polyps completely embedded in the coenenchyma.

It would be difficult to imagine that such extreme differences as that given in figs. 49 and 51 of *S. flagellum* could occur in one species, were it not for the fact that as great differences actually occur in one individual colony, e.g. figs. 77, 78, 79, and 80 of *Scirpearia furcata*.

This has been discussed in detail under the different species, so that it is necessary here to refer only to the actual existence of such a phenomenon.

(d) *Distribution*.—The distribution of the polyps has been used as a basis for generic diagnosis, so that it is essential to study this character in detail and see to what extent the various distinctions can be said to obtain. Wright and Studer (L.), p. lxxv, in defining their new genus *Scirpearella*, make the following statement:—"The polyps are arranged in rows or spirals, retractile with more or less prominent verrucae," thus separating it from *Scirpearia*, which they describe as having "the polyps seated in two longitudinal rows on each side of the stem."

Hickson, in discussing these, says:—"The genera *Scirpearia* and *Scirpearella*, however, appear to me to be still good genera. The arrangement of prominent verrucae in *two* rows in the former genus and in a *spiral manner* in the latter, combined with other characters, renders them relatively easy of identification."

Let us for the present disregard the question of spicules, and consider the group as a whole with regard to this character.

It must be borne in mind that since the publication of the work of these authors, the species *Juncella trilineata* Thomson and Henderson has been established; and the present memoir contains another new species, namely, *Scirpearia quadrilineata*. The result of this is that unless the distinction drawn between these two genera is modified, these two species would necessitate the establishing of two new genera to include them.

The first problem before us then is:—*What is the factor underlying the distribution of the verrucae?* The answer to this question—namely, *the number of main longitudinal canals*—has already been discussed.

The only exception to this rule is what may be termed "the low verruca-

type of *Juncella juncea*." The position of these specimens is discussed later on, so that it is unnecessary to enter into it here.

A short discussion on the distribution of the verrucae in a number of specimens which have come under our observation may prove useful in arriving at some general conclusion. It is unnecessary to take these in any definite order; but a division into three groups may serve to emphasize some of the more salient characteristics.

1. *Scirpearia profunda*.—The polyps are disposed in two longitudinal series; this arrangement may be obscured in the older parts, and then the disposition may simulate a spiral. Near the base four rows may occur in each series; but this number diminishes in the younger parts, so that near the tip there is only a single row alternating on opposite sides.

*Scirpearia pectinata*.—In no case do the polyps occur on the main stem. On the primary branches they are restricted to the outer aspect, i.e., the side diametrically opposite the one from which the secondary branches arise. On the secondary branches they are disposed on the two inner surfaces. In the upper half of the secondary branches the polyps may encroach on the bare spaces and appear as if distributed all over the coenenchyma.

*Scirpearia anomala*.—The polyps are confined to two longitudinal lateral tracts separated by two bare spaces. Near the base of the colony and also in the younger parts near the tip there is a single row of polyps in each series; but in the intermediate portion there are two irregular rows owing to crowding and the interposition of young polyps.

*Scirpearia verrucosa*.—The distribution of the polyps is as follows:—The lower part bears no polyps; this is followed by two bare tracts which diminish in size to two distinct lines from which the polyps diverge at acute angles.

*Scirpearia flagellum*.—The lower part of the stem is devoid of polyps; this is surmounted by two opposite longitudinal bare tracts which persist to the tip of the colony. On the other two sides the polyps are disposed in a single row in each series. This gives the colony a markedly bilateral appearance. The verrucae stand sometimes in opposite pairs, but the more common arrangement is alternate.

*Scirpearia thomsoni*.—The polyps are disposed in two longitudinal series on opposite faces, each of which consists of from two to four irregularly alternating rows.

*Scirpearia furcata*.—The polyps are arranged in two longitudinal series separated by two narrow bare strips which become more indistinct, but still visible towards the tip. In each series the polyps appear in rows diverging

from the bare tracts. Transversely, four or five is a common number in each series.

2. *Juncella trilineata*.—The polyps are arranged in transverse rows of three to four, but many smaller polyps occur which break this regularity. For a short distance from the ends of the branches the polyps occur in three single rows; but passing downwards two, three, four, or more are to be seen, and, scattered amongst these, are immature forms, so that all that may be said with regard to the disposition of the verrucae is that they occur in three longitudinal groups. The exact number in a transverse row depends on the position in the colony and on the stage of development. The three longitudinal series are separated by three distinct bare tracts.

3. *Scirpearia quadrilineata*.—The polyps are grouped in four definite longitudinal series separated by four bare spaces which correspond in position to the four main canals. Each series consists of a single row; but near the middle of the colony they are somewhat crowded, and give an appearance of two rows, due, in great part, to displacement and the interpolation of young polyps.

From these descriptions the following conclusions will be at once evident:—

- (1) The polyps are always arranged in a certain number of longitudinal series which are definite for the species.
- (2) This number is dependent on and is the same as the number of longitudinal main canals.
- (3) The number of transverse rows in each series may vary according to the position in the colony, so that no definite number can be regarded as specific.
- (4) The number of rows generally increases in the older parts.
- (5) This is due to the interpolation of young polyps.
- (6) Near the base of a colony the different series may so approximate, owing to overcrowding, as to almost obliterate the bare tracts.
- (7) This may result in a spiral appearance which is not inherent, but secondarily produced.
- (8) A similar false spiral appearance may be produced by a torsion of the whole colony.

We have now reached a point when it is necessary to ascertain to what extent the distribution of the verrucae may be regarded as of taxonomic importance.

The question of a spiral arrangement is certainly inadmissible, as is also the number of transverse rows in any series; so that to us it seems that the

only character which may with certainty be used as a basis of classification is the number of longitudinal series as defined by the number of large main canals.

(4) AXIS.

The axis consists of a horny substance whose chemical composition has never been thoroughly investigated, and which is insoluble in the more common organic solvents.

This is impregnated with carbonate of lime.

The axis is deposited in the form of thin concentric laminae, so that a cross-section (fig. 3) shows annular markings. These are more densely calcareous towards the centre and appear whiter, so that the axis has often been described as having a calcareous core. This is not actually the case, however, as the horny material exists even in the very innermost layers. In the younger parts of the colony there is very little lime deposited, so that it is softer and more flexible.

It is noteworthy, however, that even in colonies attaining a height of 6 feet or more the axis is flexible almost to the very base. Near the base, however, it is very hard, and is cut with a knife only with difficulty. The actual hardness varies in different specimens of the same length.

There are small ridges and furrows on the surface (fig. 3) which give the cross-section a serrated outline. These, as has been already explained, correspond to the canals of the inner longitudinal series and diminish in number from the base upwards (fig. 11, *a*, *b*, and *c*).

The colour varies in the different colonies; but, as a rule, it is olive-green towards the base, passing to pale yellow near the tip. In some specimens, however, it is almost white throughout, due in great part to a larger deposition of lime, and consequently, in these, the axis is less flexible and more brittle.

The increase in the thickness of the older part of a colony is due, not to an increase in the thickness of the coenenchyma, but almost entirely to an increase in the thickness of the axis (see figs. 10, 13, 19, and 43).

(5) SPICULES.

The spicules of this group are characterized by their extreme smallness; in fact, in no other group of Alcyonaria do we find the predominant spicule so minute. Measurements of these with any precision are only possible with a high magnification.

The largest measurements for the group, viz., those in *Nicella dichotoma*, are only 0.25 mm.  $\times$  0.06 mm.; but in the genus *Juncella* the largest are those in *Juncella trilincata*, which are over 0.076 mm.  $\times$  0.038 mm.; while in

Scirpearia the largest are those of *S. anomala*, viz., 0.15 mm.  $\times$  0.034 mm., while in *S. pectinata* the largest are only 0.061 mm.  $\times$  0.023 mm.

It is not necessary here to enter into the details of all the different kinds of spicules and their variations which occur throughout the group, as this is more fully dealt with under the various species, and the figures given there will, moreover, give a much better idea of these than a lengthy description. At the same time it might be well to define in a general way the various types which have been described.

(a) *Clubs*.—Fig. 4 (a–g) gives some idea of the variations of this type. The general shape approaches that of the well-known Indian-club; and the most important characteristic is the fact that the warts or spines on the club-portion are all directed away from the shaft, the central part of which is smooth. The spines do *not* arise perpendicularly (see also figs. 14, 23, and 26).

(b) *Double-clubs*.—Fig. 5 (a–b) shows two variations of this type. They have the shape of what are usually known as dumb-bells. There is a distinct median constriction which may be more or less well defined, and may vary in length as well as in breadth (see figs. 27, 65, 75, and 113). The warts may be large or small, smooth, papillose, or very warty, but all arise perpendicularly from the *head* (figs. 87 and 113), or they may be situated either close together or wide apart; and, according to which method occurs, the head will be regular or irregular in outline (contrast figs. 63 and 65). The head itself may be hemispherical or slightly conical (contrast figs. 54 and 65). Fig. 6 (a–d) shows characteristic variations of this type as seen in *Juncella*.

(c) *Double-wheels or capstans*.—Fig. 7 (a and b). This type consists of a cylindrical shaft on which there are two whorls or warts. The ends of this shaft (the hubs) may be either almost smooth or markedly warty.

(d) *Elongated double-clubs*.—This type may be derived from the typical double-clubs, and merges gradually to another form which is sometimes described as *double spindles*, and this again may pass into the *simple spindle*. Fig. 8 a, b, and c show how these merge imperceptibly into one another. In the cases we have described, however, these spicules are all of about the same size, so that the distinction is made chiefly on the basis of the amount of constriction visible and the proportionate length of the “head” to the constriction (see figs. 63 and 65).

(e) *Simple spindles*.—In certain species, e.g. *Nicella dichotoma* (see fig. 114), there is a type of spicule which may be described as a simple spindle, and which in size contrasts so strongly with the double-clubs that there are no intermediate stages connecting the double-club with the spindle. (See also fig. 118 of *Nicella moniliforme*.)

The different variations which occur in these types will be considered in detail in describing the different species ; but certain generalizations must be briefly referred to here.

It is very important when describing spicules from any colony to state precisely from what part of the colony the preparation has been made. New species have been established on slight differences in the size and shape of spicules, and also on the preponderance of one type of spicule over another.

With a view to testing the degree of certainty with which this procedure might be justified, we have made different preparations under different conditions from the same colony ; and we now give the results derived from over 500 preparations.

(1) The different types of spicules retain their own distinct characteristics, no matter from what *level* of the colony they may be taken.

(2) Spicules from different levels of the same colony or from colonies of different ages show marked deviations in absolute size, but *not in proportionate size*.

(3) Spicules in the coenenchyma alone differ from those in the verrucae alone, e.g. in *Scirpearia furcata*, the double-club type, with hemispherical ends, is confined to the coenenchyma, whereas the elongated double-club is restricted to the verrucae. This obtains in all specimens examined.

It therefore follows that when examining spicules for specific determination the factor of primary importance is the *character* of the spicules. Next comes the average size of these spicules ; while of no importance whatever is the proportionate numbers of each type, as this depends on the proportion of coenenchyma and verrucae taken for the preparation.

If, then, a single preparation be made from a certain part of a colony, and no criterion be given as to the exact age of this portion, subsequent workers will experience great difficulty in making preparations from a similar part. To obviate this difficulty another method may be employed, namely, to take coenenchyma and verrucae from different levels for the single preparation, and so obtain a *representative sample* of the spicules of the specimen. This method has been found to be of great service in identification, and is the one employed in the preparation of this memoir.

Now it has been seen that the disposition of the verrucae is not a constant even in a single specimen, and that its inclusion as a generic character is untenable. If therefore the separation of the specimens of this Juncellid-group of the Gorgonellidae into genera is to be accomplished, it must be based on the character of the spiculation.

If a preparation of spicules be made in the manner described, there should be no difficulty in at once deciding whether or not the type described and figured, as a "club," is present or not. (See figs. 4, 14, 23, and 26.) On the other hand, figs. 114, 115, 116, and 118 give a good idea of the "long-spindle type" and its proportion to the small double-club. Any of the figures given of the various species of *Scirpearia*—e.g. figs. 27, 31, or 65—will at once mark these off as quite distinct from the other two types.

#### VI.—POSSIBLE AFFINITIES OF THE GORGONELLIDÆ.

In the "Challenger" Report on the Alcyonaria (vol. xxxi.), Wright and Studer divide the Gorgonacea into two large sections :—

- i. Scleraxonia, and
- ii. Holaxonia.

In the Scleraxonia they recognize the Sclerogorgiidae as a distinct family, with the following characters :—"In the representatives of this family a distinct axis is formed of a tissue consisting of numerous closely intercalated elongated spicules, with dense horny shields. The axis is surrounded by longitudinal canals, into which there open the reticulated coenenchymatous canals uniting the polyps."

In the Holaxonia there occurs the family Gorgonellidae, in which "the axis is lamellar and calcareous, but retains its shape after the extraction of the calcareous matter."

The nature of the "calcareous matter" is, however, not specified, so that it is very difficult to interpret exactly what may have been the opinion of these authors.

In "A Treatise on Zoology," part II., Bourne divided the Alcyonaria into five large orders as follows :—

- (1) Stolonifera.
- (2) Alcyonacea.
- (3) Pseudaxonia.
- (4) Axifera.
- (5) Stelechotokea.

The Stolonifera, Alcyonacea, and Stelechotokea are sufficiently distinct, and most certainly have no connexion with the Gorgonellidae, so that any further reference to them would be superfluous.

The Pseudaxonia have been described as "Synalcyonacea forming upright, branched colonies. The zooid cavities short; the zooids embedded in a coenenchyma containing ramifying solenia and numerous spicules. The

coenenchyma differentiated into a cortical and medullary portion, the latter containing spicules different from those of the cortex, densely crowded together, and *sometimes cemented together to form a supporting axis.*"

One of the families of this order—namely, the Sclerogorgiidae—is thus defined:—"The medullary mass forms a distinct axis, consisting of closely packed, elongate spicules, with dense horny sheaths. The axis does not contain solenia, but is surrounded by longitudinal canals—i.e., by large solenia—which are connected with the zooid cavities by ramifying solenia." Of the genus *Suberogorgia*, Gray, in his original description (Proc. Zool. Soc., 1857, p. 159), says:—"Axis pale-brown, formed of rather loosely concentric fibrous laminae, containing a large quantity of calcareous matter."

From the *Pseudaxonia* the *Axifera* are thus differentiated:—"Synalcyonacea forming colonies consisting of a coenenchymatous rind, investing a horny or calcified axis. The axis may be horny or composed of a calcified horny substance. . . . It never contains solenia, and is never formed of fused spicules. The coenenchyma completely invests the axis, and contains solenia, and calcareous spicules embedded in the mesogloea."

Bourne does not include the Gorgonellidae in his scheme of classification; and as the nature of the calcareous constituent in this family has never been investigated, or even commented upon, it is impossible to say whether they are *Pseudaxonia* or *Axifera*.

The time at our disposal has not permitted of a detailed investigation of this very important problem; but as a contribution to this study the following observations may be useful:—

*Suberogorgia*.—An examination of the axis of a specimen of this genus reveals the following features:—

(1) It consists of a horny matrix, in which large irregular spicules are embedded longitudinally. These spicules are easily seen with a strong lens, and appear to be deposited concentrically.

(2) The axis after decalcification retains its original shape.

(3) Prolonged boiling in caustic potash causes a slight disintegration; and the individual spicules may thus be separated.

(4) The spicules of the axis are quite different from those of the coenenchyma.

(5) A thin horny layer may be detached from the axis, in which the spicules may be seen embedded.

*Juncella elongata* var. *capensis*.—Hickson (XIII.) described an Alecyonarian from Cape Colony under this name, but at that time the spicules of this species were unknown. Subsequent study, and a consequent resuscitation of

that old but imperfectly known species, have necessitated the removal of the Cape specimen from this genus.

In many respects this colony is unique; and the writer has described it separately as *Dendrogorgia* (n. g.) *capensis*, Proc. Roy. Phys. Soc., Edin., vol. xviii. (1910), p. 62. The following notes on the axis are of great importance in this connexion:—

- (1) The axis consists of concentric laminae.
- (2) These laminae are composed of a horny matrix, in which long irregular spicules are embedded horizontally.
- (3) The horny substance preponderates in amount over the calcareous matter, so that even with a lens the spicules are not very evident.
- (4) The spicules differ greatly in size and shape from those of the coenenchyma.
- (5) Prolonged boiling in strong caustic potash results in a partial separation of these spicules.
- (6) *When the coenenchyma is detached from the axis, a thin, white, transparent film is generally found adherent to it. If this be peeled off and placed under a microscope with a one-sixth objective, spicules identical with those of the axis are seen embedded in it.*

From these facts it is at once evident that the axis in the case of this specimen is distinctly sclerogorgic. It consists of spicules different from those in the coenenchyma embedded in a horny matrix, the individual components of which are laminae deposited concentrically; and, further, it is possible to separate the outer layer, which is usually detached with the coenenchyma.

*Juncella juncea* may be taken as a type of gorgonellid axis, and the following are the chief points observed:—

- (1) The axis consists of a horny substance impregnated with lime.
- (2) The horny material greatly preponderates over the calcareous.
- (3) The axis is very hard, and is cut with difficulty.
- (4) It is impossible to see individual spicules either in a cross-section or a longitudinal section; but
  - (a) The axis is deposited in the form of concentric laminae.
  - (b) A thin layer is usually found adherent to the detached coenenchyma,
  - (c) This layer may be separated from the coenenchyma.
- (5) It contains small spicules not very unlike those of the coenenchyma, but different from them.

With regard to the coenenchyma in these three groups, the following notes are interesting:—

(1) In all of them there is a circle of large canals separating the coenenchyma from the axis.

(2) Near the periphery of the coenenchyma there is also a circle of longitudinal canals which communicate directly with the polyps.

(3) These two series are united by numerous interlacing transverse solenia.

The polyps are very similar in all three groups. There is no definite distinction into verruca and anthocodia. There is a pseudo-operculum formed of small spicules on the aboral surface of the tentacles in all three groups. The polyps are in all cases capable of complete retraction into the coenenchyma.

A further point of similarity may be pointed out in the case of Suberogorgia and Juncellids, namely, the possession of a definite number of longitudinal canals in the inner series larger than the others, which determine the distribution of the polyps.

It would be premature to draw any hard and fast conclusions from these few observations; but it may be considered a question whether the three groups taken in the following order, (1) Suberogorgia, (2) *Dendrogorgia capensis*, and (3) the Juncellids proper, may not represent a line of evolution. In the first of these the spicules of the axis are large, and there is only a small amount of horny matrix; in the second the spicules are smaller, and there is a larger proportion of horny material; while in the last the spicules (if such is the nature of the calcareous matter) are extremely small, and the proportion of horny substance to the calcareous is enormously increased.

For the present, and until the exact nature of the limy deposition in the axis of the Gorgonellidae is investigated, it is therefore inadvisable to rank them with the Axifera, and it is more than probable that their affinities are closer to the Pseudaxonia.

#### VII.—DIVISION OF THE GORGONELLIDAE INTO GENERA.

Before proceeding to formulate a scheme of classification which may approximate to a natural classification, and which will be based on the foregoing considerations, it may be well here to recapitulate the most recent diagnosis of the genera under consideration, and see to what extent each of these may be considered valid.

*Juncella*.—The colony is simple or branched, the polyps are sometimes small, disposed in two lateral rows, sometimes with well developed and

elongated verrucae. The coenenchyma is thick, with an external layer which contains simple and double clubs.

*Scirpearia*.—The colony is simple, with a cylindrical calcified axis and thin coenenchyma. The polyps are seated in two longitudinal rows on each side of the stem. The spicules are double-clubs and spindles.

*Scirpearella*.—The colony is simple or very feebly branched. The axis is calcareous, brittle, smooth or grooved. The polyps are arranged in rows or spirals, retractile, with more or less prominent verrucae. The coenenchyma is moderately thick and finely granular. The spicules are spiny spindles and double-clubs.

*Ellisella*.—The colony is simple or dichotomously branched, with a thick coenenchyma, and slightly developed verrucae, which are disposed in two rows on the axis. The coenenchyma contains both double-clubs and spindles.

*Ctenocella*.—The colony is branched in one plane, and so that all the simple twigs arise in an ascending order from the upper surface of the stem. The verrucae are short on two sides of the twigs. There are distinct median furrows. The spicules are mostly double-clubs; those of the polyp-calices are, according to Ridley, somewhat different from those of the coenenchyma, being longer and provided with two, often three whorls of tubercles. The inner whorls so approach in the middle of the spicules, that the median naked zone, which is characteristic of the spicules of the coenenchyma, is here absent.

*Nicella*.—The colony is upright, branched, with a thin coenenchyma, and protruding verrucae, which arise perpendicularly, and appear to be terminally truncated. The polyps arise from either side of the stem and branches, leaving a middle space free. The spicules form a cortical layer of small double-clubs, and an internal layer of long densely warty spindles.

An examination of these diagnoses reveals the fact that we have here to deal with three distinct groups. The first of these is represented by the various species of the genus *Juncella*, and is characterized by the fact that its spicules include simple clubs. The second is restricted to the genus *Nicella*, and is distinctly separated by the character of its spicules, which include small double-clubs and long, densely warted spindles.

The third comprises *Ellisella*, *Scirpearia*, *Scirpearella*, and *Ctenocella*, which agree in having neither clubs nor long spindles, but whose spicules all include double-clubs. These distinctions may be tabulated thus:—

A. Spicules include clubs (*Juncella*).

B. Spicules do *not* contain clubs—

(1) Spicules include extremely elongated spindles (*Nicella*).

(2) Spicules do not contain elongated spindles (*Ctenocella*,  
*Ellisella*, *Scirpearia*, *Scirpearella*).

In view of our previous discussion on the various characters which may be considered of taxonomic importance, we may now take each of these genera in rotation.

(1) *Ctenocella*.—Only one species of this genus has so far been described, so that the generic diagnosis given above is a recapitulation of its specific characters. In spiculation it is essentially of the *Scirpearia*-type; and the particular kind of spicules described above is quite characteristic of the group. It corresponds to the elongated double-club, which may approximate to the double-spindle, and eventually to the simple spindle which has been already described. It has been my privilege to examine a large number of colonies of this species (*pectinata*), and the only character in which it differs essentially from other genera is its peculiar mode of branching. The secondary and tertiary branches (see figs. 36-41), however, are long, simple, and flagelliform; and if one of these detached branches be taken for identification, it will at once be referred to the genus *Scirpearia*. The disposition of the verrucae and the types of spicules correspond in every detail with the diagnosis of *Scirpearia*. Is it justifiable, then, to continue recognizing a genus on the basis of its branching alone, when a part of the same colony may be indisputably referred to another genus? We prefer to answer this question in the negative, and consequently abolish the genus *Ctenocella*, and rank the only known species under the name *Scirpearia pectinata*.

(2) *Ellisella*.—It will be remembered that Kölliker in 1864 first drew attention to the spicules of this family, and, with the small amount of material at his disposal, separated the genus *Juncella* into two groups.

(1) Those with clubs (*J. juncea* and *J. gemmacea*), and (2) those without clubs (*J. elongata*).

Studer (1878) in revising the family limited the generic diagnosis thus:—

(1) Spicules: clubs, and double-clubs (*Juncella*).

(2) Spicules: double-clubs, and spindles—

A. Calyces not prominent (*Ellisella*).

B. Calyces markedly projecting (*Scirpearia*).

In discussing the question of the nature of the verrucae we pointed out that this character could not be relied upon for even specific determination, so that Studer's groups A and B, or, in other words, the genera *Ellisella* and *Scirpearia*, cannot on this basis be regarded as distinct.

In the descriptions of the various species of *Ellisella* which have since been established no further character of generic importance has been added, and an examination of the generic diagnosis of *Ellisella* and *Scirpearia*, given by Wright and Studer, shows them to be identical. We have examined the

type specimens of *Ellisella*, and compared them with authentic species of *Scirpearia*, and could find no reason for separating them.

Hickson (xv, pp. 818-819), in his valuable contribution to the study of this group, has suggested the abolition of the genus *Ellisella* and has united the species included under that name to those of the genus *Juncella*. He, however, divides the species so included into two groups—(1) those with clubs and (2) those without clubs, the former of which, as will be evident, corresponds to *Juncella*; and the latter, with the exception of *J. spiralis*, which will be discussed later, to *Ellisella* as defined by their spiculation.

The result of this is that the genus *Juncella*, which was distinguished by the presence of the clubs amongst its spicules, now includes forms whose spiculation is identical with that of *Scirpearia* and *Scirpearella*.

The question now resolves itself into, "How are we to distinguish between (1) those species of *Juncella* whose spicules contain no clubs, (2) *Scirpearia*, and (3) *Scirpearella*?" In other words, we have still to find generic characters and separate *Ellisella*, *Scirpearia*, and *Scirpearella*.

As the result of an examination of *all* the type species of *Ellisella*, *Scirpearella*, and *Scirpearia* (with the exception of *S. flagellum*, of which, however, we have seen numerous authentic specimens in the Monaco collection), we are fully convinced that nothing in the spiculation of these types is of sufficient importance to be used as a generic character, so that it is incumbent upon us to examine in detail the other features which have been used as diagnostic.

*Branching*.—*Scirpearia* is described as simple, *Scirpearella* as simple or very feebly branched, and *Ellisella* as simple or dichotomously branched. Now the question of branching, as has been already shown, is of no importance in diagnosis. Specimens otherwise identical are described in this memoir, in which one may be of great length and simple, another elongated and bifurcating, while a third may be of no exceptional height and yet very markedly branched. A very good example of this may be seen in *Scirpearia furcata*. Contrast (1) the specimens from Mergui—(2) that originally described by Thomson and Henderson as *Scirpearia*, sp., and (3) the specimen from Providencé Island, all of which are included in this report. The very fact, however, that a species of *Scirpearia* has been described in which branching occurs shows the futility of relying upon this feature.

*Nature of the Verrucae*.—The question of prominent or non-prominent verrucae has already been discussed, and, as it has implicitly been abandoned by most authors, need not occupy our time here; but it is essential to point out that the omission of this as a generic character almost finally necessitates the abolition of the genus *Ellisella*.

We would, therefore, in view of these considerations, put forward the following emended classification, and proceed to define the various genera in terms of such characters as seem to warrant attention.

Family **GORGONELLIDAE.**

JUNCCELLID GROUP.

Division 1. Spicules include *clubs* (*Juncella*).

Division 2. Spicules do not include *clubs*—

A. Spicules include *long* warty spindles and *small* double-clubs (*Nicella*).

B. Spicules include double-clubs and elongated double-clubs (*Scirpearia*).

VIII.—EMENDED DIAGNOSES OF THE FAMILY AND GENERA.

Family **GORGONELLIDAE.**

Specimens belonging to this family may be either simple or branched. When simple, they frequently attain a length of three feet, though colonies of five or six feet long are not uncommon. When branched, the branching may be (1) very sparse, (2) more frequent and dendriform, or (3) flabellate. The branches are usually long and flagelliform. The coenenchyma is usually thin, arenaceous on the surface, and very granular throughout; it is densely packed with small spicules, and is separated into an outer non-canal-bearing part and an inner canal-bearing part.

The canal system consists of two longitudinal series, situated circumferentially; the inner series separates the coenenchyma from the axis, and the outer separates the two parts of the coenenchyma mentioned above. Between these two series, solenia ramify in all directions and unite them. The canals of the outer series are all equal in size; but in the inner series there is a certain number, definite for the specimens, larger than the others. These are known as the main longitudinal canals. The most frequent number is *two*, but *three* and *four* also occur.

The polyps are disposed in a certain number of longitudinal series, which are defined by and correspond to the number of main longitudinal canals; these are separated by longitudinal bare tracts, which occupy the region of the main canals. The verrucae vary greatly in shape, not only in different specimens, but in different parts of the same colony. They may project considerably or may be depressed below the surface of the coenenchyma. In each series there may be one or more longitudinal rows; but the number is

not constant at the various levels in any one colony. The anthocodiae are very simple; the tentacles are short and conical, and bear a single row of short, simple pinnules on each side. There are scale-like spicules on the aboral surface of the tentacles.

The axis is composed of a horny substance impregnated with carbonate of lime. It consists of concentric laminae, which are deposited on the periphery; and it retains its shape on decalcification.

The spicules are extremely minute, and contain the following types:— (1) Indian club-shaped forms known as *clubs*; (2) dumb-bell forms known as *double-clubs*; and (3) spindle-shaped forms or *spindles*. Intermediate forms such as elongated double-clubs and double-spindles may also occur.

#### Genus *Juncella* emend.

Colony simple or branched; the coenenchyma is usually thick; the polyps are distributed (1) irregularly over the whole coenenchyma or (2) in definite longitudinal series, defined by the position of a number of main canals, constant for the species. The verrucae (1) may be sunk within pit-like depressions, (2) may be low and dome-like, or (3) may be sub-conical and adpressed to the stem; all these conditions may appear in one colony. The axis is formed of concentric layers of a horny substance impregnated with lime; there is usually a more densely calcareous core.

The coenenchyma consists of two layers—(1) an outer, containing no canals, in which the polyps are retracted; and (2) an inner, which is bounded both externally and internally by a circle of small canals, and which is penetrated by a network of small solenia uniting these two series.

The outer series of canals communicates directly with the polyps. A certain number, two or three, of the canals of the inner series, symmetrically arranged, are larger than the others, and are known as the main canals. Their position defines in most cases the distribution of the polyps. The spicules are extremely small; they contain *clubs*, but otherwise are typical of the family.

#### Genus *Scirpearia* emend.

The colony may be (1) simple and flagelliform, (2) slightly branched, (3) much branched and dendriform, or (4) branched in one plane. The branches themselves are usually long and flagelliform. The coenenchyma varies greatly in thickness in the different species. The canal system is typical of the group; so far only species with two or four large main longitudinal canals are known. The verrucae are disposed in a number of longitudinal series, the number of which is the same as the number of main canals. As in *Juncella* the number of transverse rows in each series varies

in the different parts of the colony. The verrucae themselves vary in shape and size according to the stage of retraction and also according to their position in the colony. They may be elongated and conical, wart-like, or even depressed below the surface of the coenenchyma. The axis is composed of concentric laminae impregnated with lime; the surface is marked by longitudinal ridges and furrows; but the number of these diminishes towards the tip of the colony. The spicules contain "double-clubs," but neither "clubs" nor *extremely long* "double-spindles" or "spindles."

Genus *Nicella* emend.

The colony may be simple, slightly branched, dichotomously branched or variously branched, with frequent anastomoses in one plane. The coenenchyma is thin and finely granular; the surface presents an arenaceous appearance. The polyps are disposed in longitudinal series which alternate with, and correspond in number with, the main longitudinal canals. In the species so far known there are two main longitudinal canals. The number of rows in any series varies according to the position in the colony; and in the older parts the polyps may encroach on the bare tracts so as to almost obliterate them. The verrucae vary in shape and size according to the stage of retraction; when expanded they stand usually at right angles to the stem and are terminally truncated; when fully retracted they are low and conical or dome-like; intermediate stages always occur. The axis is composed of concentric laminae, and is densely calcareous; it is typically Gorgonellid in character. The spicules consist of small double-clubs and slightly elongated double-clubs, but characteristic are *elongated double-spindles* and *spindles*. These latter types are quite distinct, and there are no intermediate forms linking the two sets—i.e. double-clubs and spindles—together. They are also usually large in most species.

IX.—Genus *Juncella* emend.

A historical review of this genus has already been given, and also an emended diagnosis. In the restricted emended sense—i.e. those Gorgonellids whose spicules include "clubs"—the following species must be taken into consideration:—

1. *Juncella juncea* Pallas.
2. *Juncella fragilis* Ridley.
3. *Juncella flexilis* Studer.
4. *Juncella barbadiensis*<sup>1</sup> Wright and Studer.

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<sup>1</sup>It is extremely doubtful whether the specimen identified by Wright and Studer as *J. barbadiensis* is the same as the original specimen of that name, so that it has been considered advisable to keep them separate. The "Challenger" *J. barbadiensis* is a *Juncella*; the original may not be.

5. *Juncella gemmacra* Valenciennes.
6. *Juncella racemosa* Wright and Studer.
7. *Juncella miniacea* Thomson and Henderson.
8. *Juncella trilineata* Thomson and Henderson.

But in addition to these the following species have been also referred to this genus :—

9. *Juncella santae-crucis* Duch. and Mich.
10. *Juncella funiculina* Duch. and Mich.
11. *Juncella barbadensis* Duch. and Mich.
12. *Juncella vimen* Ellis and Solander.
13. *Juncella calyculata* Ellis and Solander.
14. *Juncella hystrix* Valenciennes.
15. *Juncella sureulus* Johnson.
16. *Juncella laevis* Verrill.
17. *Juncella extans* Verrill.

Species 9–17 are, however, so imperfectly known that it is absolutely impossible to include them in any scheme of classification. In several cases they are names without descriptions; and in the others, the descriptions are extremely vague, and are based on characters which are now known to be of no specific value. In no case have the spicules been investigated, so that it is even impossible to say whether they actually belong to this genus or not; in fact, it is more than probable that they are not all referable to *Juncella*.

I have carefully searched through several old collections for authentic specimens of any of these; but the result has been negative, so that in the absence of type-specimens, but for the sake of completeness, it has been decided to place them in a group—"incertae sedis"—by themselves, and give such references and descriptions as are available.

An attempt, however, has been made to trace the affinities of species 1–8. Each of these is discussed in detail under its place in the emended classification suggested later, so that it is necessary here only to consider the characters on which the classification is founded.

The first and most important of these is "*the number of main longitudinal canals*," and this at once separates off *Juncella trilineata* from the others.

An examination of the spicules marks *Juncella racemosa* as distinct (see figs. 14 and 23). In addition to this, however, the general nature of the colony and the mode of branching are distinctive for this species, which under the present system includes *Juncella miniacea*. There, therefore, remain only species 1–5 to be considered. *Juncella flexilis*, *J. fragilis*, and *J. barba-*

*densis* have proved to be but young stages of *J. juncea*, and must therefore be included under the older name; so that the number of species is now restricted to two, viz., *Juncella juncea* and *Juncella gemmacea*. There can be no doubt that these two names have been very loosely used in the identification of specimens, and with great justification; for after an examination of the macroscopic and microscopic characters of a very large number of each of these, it must be confessed that it is almost impossible to distinguish between a branch of *Juncella gemmacea* and a portion of a colony of *Juncella juncea* of about the same size.

Large specimens of *J. juncea* and complete colonies of *J. gemmacea* are unmistakable on account of the great difference in the nature of the colonies.

In the former the colonies are always simple or sub-simple, while in the latter they are very much branched and markedly dendriform. Solely for this reason has it been considered justifiable to maintain these as distinct species.

The spicules are identical both in type and measurements; but the extreme nature of the branching, which commences almost at the very base of the colony in the case of *J. gemmacea*, and the normally simple character of *J. juncea*, and the great length and size to which colonies of the latter species may attain, seem to justify their recognition as distinct species. It must be noted, however, that it would be extremely inadvisable to attempt to distinguish between one of the long terminal twigs of *J. gemmacea* and the tip of a colony of about the same thickness as *J. juncea*. For this reason it is difficult to decide exactly to what species certain records refer when these have been based on fragments.

In *J. juncea* there are two externally different types, but morphologically these are the same. In one of these the lateral bare tracts which correspond to the two main longitudinal canals are evident throughout, but in the other there is no trace of these.

The importance of this has been discussed under the species; and it has been considered highly inadvisable to separate them, unless as varieties. This step has been taken only to obviate any future misapprehension.

I would therefore suggest the following classification:—

#### Species of *Juncella*.

##### A. Longitudinal main canals *two* in number.

- (1) Colony simple, flagelliform—*J. juncea* Valenciennes, emend.
- (2) Colony much branched and somewhat bushy; branches flagelliform—*J. gemmacea* Valenciennes, emend.

- (3) Colony delicate, branched in one plane; branches tending to arise from one side—*J. racemosa* Wright and Studer.
- B. Longitudinal main canals *three* in number.
- (4) Colony branched as in *J. gemmacea*—*J. trilineata* Thomson and Henderson.

X.—*Juncella juncea*.

- Junci lapidei* Pliny, Hist. Nat., p. 13, c. 25.
- Palmijuncus albus*, Rumph, Amb. vi, p. 126.
- Keratophyton simplex* Seba, Thes. 111, t. 105, fig. 1a.
- Gorgonia juncea* Pallas, xxviii, p. 180.
- "    "    Pallas, xxvii, p. 226.
- "    "    Esper, vii, ii, p. 26, Pl. LII.
- "    "    Lamareck, xxiv, ii, p. 15, n. 34.
- "    "    Lamouroux, xxv, p. 419.
- "    "    Dana, iii, p. 664.
- Helicella* "    Gray, xi, p. 481.
- Juncella* "    Val., xvi, p. 14.
- "    "    Val., xlv, p. 182.
- "    "    Milne-Edwards and Haime, xxvi, p. 186.
- "    "    Verrill, xlvii, p. 37.
- "    "    Gray, xii, p. 204.
- "    "    Köl liker, xxiii, p. 140, t. 18, f. 45, 46.
- "    "    Thomson and Henderson, xxxix, p. 314.
- "    *gemmacea* Thomson and Henderson, xxxix, p. 313, Pl. iv, figs. 4 and 5.
- "    *juncea* Ridley, xxxiii, p. 345.
- "    "    Gray, xii, p. 25.
- "    "    Hickson, xv, p. 820.
- "    "    Studer, xxxiv, p. 659.
- "    "    Studer, xxxvii, p. 116.
- "    "    Wright and Studer, l, p. 158, Pl. xxxiv, fig. 12; Pl. xli, fig. 38.
- "    "    Kent Saville, xxi, p. 92.
- "    *flexilis* Studer.
- "    "    Germanos, viii.
- "    "    Hickson, xv, p. 821.
- "    *fragilis* Ridley, xxxiii, p. 347, Pl. xxxi, fig. D.
- "    "    var., xxxiii.
- "    "    Thomson and Henderson, xxxix, p. 314.

*Juncella fragilis* var. *rubra* Thomson and Henderson, xxxix, p. 314.

„ *barbadensis* Duch. and Mich., v, p. 22, Pl. v, fig. 5.

„ „ Wright and Studer, l, p. 159, Pl. xxiv, fig. 14.

***Juncella juncea.***

This is a very old species, as may be seen from the Bibliography. Pallas referred it to the genus *Gorgonia*; but Valenciennes, in 1841, rightly considered it as a *Juncellid*, and placed it in the genus *Juncella*; and in this genus it has remained, and has been so regarded by most authors; but, in 1859, Gray, for no apparent reason, established the genus *Helicella* to include it. No one has, however, confirmed his opinion, so that it is unnecessary to discuss its position there. The species is a fairly distinctive one; but very little positive content has ever been given to it. Ridley, in his Report on the *Aleyonaria* collected by H.M.S. "Alert," says:—"Neither Milne-Edwards and Haime nor Valenciennes give details full enough to enable the student to identify their species satisfactorily with that of Pallas and Esper. In the 'Alert' specimens and that figured by Esper the verrucae are closely packed over the cortex. In our specimen, which is about 46 inches (1150 mm.) long by 6 mm. thick at the present broken base and 3.5 mm. thick at the tip, the basal end is almost smooth, the verrucae being either level with the surface or depressed below it; towards the middle of the length they become projecting until they reach a height of about 1.25 mm.; they are then adpressed against the surface of the cortex. A distinct median groove is to be traced along most of the stem."

This was a most important contribution, and was the first description of the variation in the size of the verrucae, which is such a marked feature in this species, and which has led to several mistakes in identification.

Kölliker, in 1865, first introduced the question of spicules into this species, and gives two figures of these (Tab. xviii, figs. 45 and 46). One of these represents a thick single-club, and the second a double-club. In the many records and short descriptions which occur scattered throughout *Aleyonarian* literature very little further was added, so that the following short description sums up the chief points upon which the species was identified. The colony is simple and elongated; the cortex is thick; the spicules contain clubs and double-clubs; the verrucae vary in size in the various parts of the colony (Ridley); the axis is hard and calcareous; there are usually two bare streaks in the coenenchyma.

Practically no attention was paid to the extraordinary fertility of variation which occurs with regard to all these characters, not only in different specimens, but also in different parts of the same specimen; nor

was there any allowance made for different stages of development. As a result of this, three species—viz., *J. fragilis*, *J. flexilis*, and *J. barbadensis*—were established on what must now be regarded as young colonies of this species. The large number of specimens, which undoubtedly belong to this species which we have been able to examine in detail with respect to the differences on which these three species were based, confirm beyond doubt the opinion of several authors—notably Ridley, Studer, Hickson, and Thomson, that these cannot be regarded as distinct.

I give here a short description of these three species, followed by a systematic study of a large number of specimens which may help to give a true estimate of the variability of certain characters and the constancy of others, and so form a basis for a definite specific diagnosis.

#### *J. fragilis* Ridley.

In 1884 Ridley established the species *fragilis* for two specimens from Queensland with the following characteristics:—Stem long, unbranched, diminishing very slowly to the tip, which may be either clavate or sharp-pointed, flexible, and easily broken. The diameter at the base is 5 mm., at the apex 3–4 mm., except when the apex consists of a fine point. The cortex is thick and creamy-white when dry; there is no trace of a lateral line in the upper three-fourths. The verrucae are small, about 1 mm. in height, clavate, closely adpressed against the cortex, crowded over all parts; axis very slender, about 1 mm. in diameter at the base and hair-like at the apex; near the base it is olive-brown, hard, and beset with longitudinal striae. The cortical spindles are the same as in *J. gemmacca*. He points out the following differences between this species and *J. gemmacca*:—

- (1) The verrucae are small and crowded.
- (2) There are no lateral lines in the upper three-fourths.
- (3) The colour is pale creamy-white.
- (4) The heads of the double stellate spicules are more abundantly tuberculated.

Later, in 1887, Ridley referred, with doubt, two colonies from Mergui to this species as a variety. One of these was white or cream-coloured, the other was pale brick-red. He notes that these specimens approach *J. juncea*, which, he says, is distinguished from *J. fragilis* by its greater size, its red colour, its larger and more distant polyp-verrucae, the presence of a space bare of verrucae above the base and by the possession of equal-ended double-stars. These specimens, he says, stand midway between *juncea* and *fragilis*.

In 1905 Thomson and Henderson referred several fragments from Ceylon to this species. The axis was marked by longitudinal striae. In some the verrucae were nearly 2 mm. in height, and the diameter of the axis was 1 mm.; in others the verrucae were much smaller, and the diameter of the axis was 2 mm. The spicules showed some variation from those in Ridley's specimens.

***Juncella fragilis* var. *rubra*.**

In the same paper Thomson and Henderson established a new variety, namely, *rubra*, to include a long, flexible, complete colony, which tapered gradually throughout its entire length. There was no trace of a lateral line or groove. The verrucae were numerous and closely adpressed, measuring about 1 mm. in height.

From the above descriptions it is evident that this species has no definite specific character. Ridley himself had doubts as to its distinctiveness; but its "simple" character at once separates it from *J. gemmacea*. The specimens from Mergui are undoubtedly *J. juncea*; but Ridley practically acknowledges this. I have examined the specimens described by Thomson and Henderson, and although these undoubtedly coincide with the description of *J. fragilis*, they also agree with young forms of *J. juncea*. A comparison of these specimens and Ridley's descriptions, with the numerous colonies of various ages which I was fortunate in obtaining at Mergui, proves beyond doubt that this species was based on young stages of *J. juncea*, so that I would suggest the merging of this species into *J. juncea*. At the same time the variations in the different characters, as seen in these specimens, are of great interest, and show how difficult it is to be certain of any species on a single or even a few specimens, especially if they are young. The question of the size of the verrucae and the presence or absence of bare spaces in this species is discussed further on, so that it is necessary here to note only its relative position in classification.

***Juncella flexilis* Studer.**

This species was established by Studer for a small specimen (probably young) with the following characters:—

"The stem is simple, rising from a flat base. The colony is only 20 cms. in height. The axis is thin and flexible, but contains lime. The polyps first arise at a level of 2 cms. from the base; they occur at first in two lateral rows, soon increasing in number, and occupying in the upper part the whole surface of the stem. The verrucae are 2 mms. long, are club-shaped, and are curved towards the stem. The coenenchyma

is thin, and contains an external layer of clubs, and below this a layer of double-clubs. The colour is dark red.

Germanos (VIII) identified a small specimen from Ternate with this species. It had two branches<sup>1</sup> (the type specimen is simple). He makes the following observations:—

The colour is orange-red. The stem is cylindrical, with a rigid axis consisting of several concentric and horny layers. The branches are much compressed, and have a flexible axis. The spicules of the coenenchyma are clubs and double-wheels. The verrucae are high, club-shaped, and are curved towards the stem; they contain club-shaped spicules; the anthocodiae are white, entirely retractile, and have small spindles.

Hickson (XV) provisionally referred some specimens to this species, but expressed an opinion that they might be young forms of *J. juncea*.

The remarks which we have made with regard to *J. fragilis* apply equally well to this species; and we would confirm Hickson's opinion and merge this species into the older *J. juncea*.

\* *Localities*.—Between Flat Island and Mauritius (Studer). Ternate (Germanos). S. Nilandu, Maldives, 25–30 fms. (Hickson).

#### ***Juncella barbadensis*.**

*Juncella barbadensis* Wright and Studer, I, p. 159, Pl. xxxiv, fig. 14.

When Duchassaing and Michelotti described this species, they emphasized characters which have since proved to be of no specific importance.

Wright and Studer, however, with considerable hesitation, regarded two small fragments in the "Challenger" collection as young stages of either *barbadensis* or *funiculina*; but at the same time note that certain identification is impossible, owing to the very brief description given by the authors and the absence of the type specimen to which reference might be made.

In the "Challenger" specimens the coenenchyma is thin, and the spicules seem related to those of the *J. juncea*. They consist of unsymmetrical clubs, double-stars and spindles, which give the same measurements as those of *J. juncea*.

Wright and Studer note that in some respects their specimens resemble *J. flexilis* Studer.

From the foregoing it is quite evident that this is not a distinct species, and I have no hesitation in referring it to *J. juncea*.

*Locality*.—Off Sombrero Island. 450 fathoms.

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<sup>1</sup> It is not improbable that this was a young colony of *J. gemmacea*.

***Juncella juncea.***

In the Mergui Collection there are numerous specimens of this species; and a study of these has enabled me to define this species with some precision. A superficial examination of these reveals two distinct types which, for the present, may be regarded as varieties with the following distinction:—

Var. *a*.—with slightly protruding verrucae and with the polyps all over the coenenchyma.

Var. *b*.—with markedly protruding verrucae and with two bare longitudinal spaces.

I would emphasize the fact that these are but *superficial* differences, and that no taxonomic importance can be attached to them—consequently I refrain from naming them. I shall first examine them macroscopically with regard to their superficial differences.

Var. *a*.—Fig. 9 (*a*, *b*, and *c*) gives a very good impression of the external appearance of this variety. The polyps are distributed irregularly over the *whole* coenenchyma, so that, at any one level, the arrangement is the same from any aspect. In the younger part of the colony—that is towards the tip—the verrucae are slightly club-shaped, and are adpressed to the axis, and are sunk in very shallow pits. About seven or eight may be seen on one transverse line (fig. 9*c*).

Towards the middle of the colony the number increases to nine or ten, the verrucae project less, appear smaller, and are sunk in deeper pits. They are not so closely packed as in the younger part (fig. 9*b*).

Near the base of the colony the appearance is quite different. The polyps are separated by intervals two, three, or more times the diameter of the verrucae. They are much smaller than in the upper parts, and the verrucae are now almost surrounded or engulfed by the coenenchyma (fig. 9*b*).

Var. *b*.—(See corresponding figures, 12*a*, *b*, and *c*.)

In this variety the polyps are restricted to two definite longitudinal series, separated by two bare spaces, whose position is marked by a more or less distinct groove. Throughout the whole colony the polyps are more protruded than in the previous variety. The colony is more slender and tapering, and the coenenchyma is thinner.

Near the tip of the colony there are usually two or three polyps in each series (fig. 12*c*).

Towards the middle of the colony four or five is a common number in a corresponding position. (Fig. 12*b* gives a view of the pit-like depression in the area devoid of polyps.)

Near the base the number increases to seven or eight (fig. 12*a*). The verrucae throughout are sub-conical and are adpressed to the stem, although in some cases they are slightly dome-like.

The following tables give a few measurements from several colonies of both of these varieties:—

TABLE A.

Specimen.	Height of Colony in Centimetres.	Diameter of Colony in Millimetres.			Diameter of axis at base.	Thickness of Coenenchyma at base.	Thickness of Coenenchyma near tip.
		Base.	Midway.	Near apex.			
1	89	7	7	5	4	1.5	2.5
2	82 +	6	5.5	5	3.5 (.5)	1.25	2.5
3	76	8	7.5	5.5	5	1.5	2.75
4	74	8.5	7.5	5	5	1.75	2.5
5	72	7	7	6.5	3.5	1.75	3.25
6	71	7	7	6.5	3.5	1.75	3.25
7	68	5	4.5	4	2.5	1.25	2
8	65	5.5	5.5	4.5	3.5	1	2.25
9	63	5	5	4.5	3	1	2.25
10	57	6	6	4.5	3	1.5	2.25
11	52 +	7.5	7	5	4.5 (.5)	1.5	2.5
12	46	6	5.5	5.5	3	1.5	2.75

TABLE B.

Specimen.	Height.	Diameter of Colony.			Diameter of axis at base.	Thickness of Coenenchyma at base.	Thickness of Coenenchyma at apex.
		Base.	Midway.	Apex.			
1	156	7.5	6.5	5	5	1.25	2.5
2	115	5	7	6.5	4	0.5	3.25
3	114	5.5	5	4.5	3	1.25	2.25
4	110	5.5	7.5	5	4	0.75	2.5
5	110	8	8	4	4.5	1.75	2
6	105	5.5	7.5	6	3.5	1	3
7	101	6.5	5	4	4	1.25	2
8	100 +	7	8.5	6	4.5 (0.5)	1.25	3
9	100	6	5	4.5	3.5	1.25	2.25
10	91	7	7	5	4	1.5	2.5
11	90	7	7	6.5	4	1.5	3.25
12	86	6	6	5	3	1.5	2.5
13	83 +	8.5	9	6	5.5 (0.5)	1.5	3
14	82	6	6	4	2	2	2
15	76	6.5	7	5	3	1.75	2.5
16	72	5	5	4	2	1.5	2
17	66	7	7	5.5	4	1.5	2.75
18	64	5	5.5	3.5	2.5	1.25	1.75
19	61	5.5	6	4.5	3	1.25	2.25
20	61	4.5	4	3.5	2	1.25	1.75
21	60	4.5	4.5	4	3	0.75	2
22	57	5.5	6	6	3.5	1	3
23	53	4.5	4.5	3.5	1.5	1.5	1.75
24	52	4.5	4.5	4	2	1.25	2
25	49	7.5	6	5	2.5	2.5	2.5
26	45	3.5	6	5.5	3	0.25	2.75
27	41	3.5	3	2.5	1.5	1	1.25

The superficial differences between the two varieties having been noted, we may consider the general morphology of the species, and see to what extent the varieties are worthy of distinction.

*Coenenchyma*.—Figs. 10 (*a*, *b*, and *c*) and 13 (*a*, *b*, and *c*) are given to show the structure of the coenenchyma at the same levels as the corresponding figs. 9 (*a*, *b*, and *c*) and 12 (*a*, *b*, and *c*) respectively. The coenenchyma may be differentiated into two distinct regions—(1) an outer superficial layer, in which the polyps are embedded, and which contains no canals; and (2) an inner layer, which is intersected by a meshwork of transverse canals.

In var. *a* the superficial layer is much thinner than the inner layer; but in var. *b* the superficial layer is the thicker of the two. At the tip of the colony there is a conical growing point devoid of polyps and having no canals. The thickness of the coenenchyma hardly varies throughout the colony.

*Canal Systems*.—This consists of (1) a longitudinal system and (2) a transverse system. The longitudinal system is composed of two series of longitudinal canals—(*a*) an outer, situated between the two layers of the coenenchyma, and with which the polyps connect directly; and (*b*) an inner, situated between the inner layer of the coenenchyma and the axis. These two systems are united by the transverse canals which penetrate the inner layer of the coenenchyma.

The number of canals in each of the two longitudinal series diminishes in number from the base of the colony upwards. This, of course, is natural, since the number of polyps also decreases.

In the inner series of longitudinal canals there are two, situated diametrically opposite one another, which are much larger than the others. They occur in both varieties; but in the case of var. *b* they correspond to the position of the longitudinal bare spaces.

The greater thickness of the coenenchyma in var. *a* may explain the absence of this phenomenon in the latter variety.

*Axis*.—The axis is marked by longitudinal ridges and furrows. The number of these correspond to the number of canals in the inner longitudinal series, and consequently diminishes towards the apex, so that this character is of no taxonomic importance (fig. 11 (*a*, *b*, and *c*)). The structure of the axis is very well seen in this species. It is composed of concentric laminae of horn, impregnated with small limy sclerites. To the inside of the canals of the inner longitudinal series a layer may be detached showing the sclerites *in situ*. The innermost layers are much more densely spiculate than the outer. The diameter of the axis (unlike the coenenchyma) gradually diminishes towards the tip of the colony, where it becomes almost hair-like, and contains very little lime.

*Spicules of J. juncea.*

The characteristic spicule is the simple club, which has been described already. A few typical variations are also shown in fig. 14. These are also double-stellate forms and double wheels or capstans. The following are some of the measurements, length by breadth, in millimetres:—

- (1) *Clubs*.— $0.11 \times 0.04$ ;  $0.1 \times 0.035$ ;  $0.09 \times 0.034$ ;  $0.085 \times 0.032$ ;  
 $0.08 \times 0.03$ ;  $0.08 \times 0.02$ .
- (2) *Double Stars*.— $0.01 \times 0.05$ ;  $0.09 \times 0.045$ ;  $0.08 \times 0.04$ ;  $0.08 \times 0.03$ .

*Distribution of J. juncea.*

- (1) *Australia*.—Port Denison, Queensland, 4 fathoms (as *J. juncea* and *J. fragilis*); Dirk Hartog, W. Australia, 45 fathoms; Mermaid Straits, N.W. Australia, 50 fathoms; Torres Straits, 7–11 fathoms.
- (2) Off Sombbrero Island, West Indies (as *J. barbadensis*).
- (3) King Island Bay and elsewhere (Mergui).
- (4) Ceylon Seas (as *J. juncea*), Gulf of Manaar (as *J. fragilis*).
- (5) Bourbon, and between Flat Island and Mauritius (as *J. flexilis*).
- (6) Ternate (as *J. flexilis*).
- (7) Maldives (as *J. flexilis*).
- (8) Off Table Island, Cocos Group, Andamans, 15–35 fathoms.

*Specific Diagnosis of J. juncea.*

Colony simple or sub-simple, elongate, sometimes filiform, sometimes very thick: the coenenchyma varies greatly in thickness in the different specimens, but is constant in each; this affects the external appearance of the colony. The canal system is of the typical Gorgonellid structure, and there are *two* main longitudinal canals. These may or may not produce an external impression; in colonies with a thin coenenchyma their position is denoted externally by two longitudinal bare tracts; but in those with a very thick coenenchyma, no trace of this is to be seen. The polyps are distributed differently in these two types; in the former they are disposed in two longitudinal series, in which there is a varying number of rows, which diminish from the base upwards; in the latter they are crowded all over the coenenchyma. The verrucae vary greatly in shape in the different parts of the colony; near the base they are low and dome-like, or may even be depressed beneath the surface of the coenenchyma; they gradually increase in size until near the top they are usually sub-conical, directed upwards, and adpressed to the coenenchyma. The axis is hard and flexible; it is composed

of concentric laminae, which consist of a horny substance impregnated with some form of calcareous matter. The surface is marked by longitudinal grooves, which correspond in number to the inner series of longitudinal canals, and therefore diminish from the base upwards. Sometimes two larger than the others are to be seen, and these represent the position of the two main canals. The spicules consist of the usual *Juncella* types, and include clubs, double-wheels, and double-stars. The colour varies from pure white, through orange, to dark red.

XI.—*Juncella gemmacea*. Figs. 15–19.

<i>Gorgonia gemmacea</i>	Valenciennes, mss. dans la Coll. du Mus. Paris.
<i>Verrucella</i> „	Milne-Edwards and Haime, xxvi., p. 185, B 2, f. 7.
<i>Juncella</i> „	Kölliker, xxiii., p. 140, t, 14, f. 4.
„ „	Wright and Studer l., p. 158, Pl. xxxiv, fig. 13.
„ „	var. Ridley, xxxii., p. 241.
„ „	Studer xxxvii., p. 117.
„ „	Thomson and Russell, xliii., p. 162.
<i>Ellisella</i> „	Gray, xii., p. 26.
<i>Ellisella maculata</i>	(pars) Wright and Studer, l.
<i>Juncella elongata</i>	var. Ridley xxxiii., p. 346.

Valenciennes in 1855 established this species to include a specimen in the Natural History Museum in Paris, under the name of *Gorgonia gemmacea* (mss. dans la collect. du Museum Paris).

In 1857 Milne-Edwards and Haime referred the species to the genus *Verrucella*, and defined it as follows:—

“Polypiéroide dont les branches, assez nombreuses et cylindriques, se dichotomisent de loin en loin, et s'écartent beaucoup entre elles; les ramuscles terminaux allongés. Coenenchyme très-friable, d'un jaune ferrugineux à la surface et blanchâtre puis de l'axe. Verrues calicifères très-saillantes, arrondées et dressées contre la tige.”

They give a very good figure, showing the mode of branching. In 1865 Kölliker removed the species from the genus *Verrucella* to *Juncella*, and noted for the first time that “clubs” occurred amongst the spicules just as in *J. juncea*. He gives two figures—(1) a club-shaped spicule (woodcut 19, 1); (2) a cross-section of the axis (PL. xiv, fig. 4).

Gray in 1870 referred this species to the genus *Ellisella* with no apparent justification. (See our Historical Note.) This change, however, was not recognized by any subsequent authors, so that Ridley in 1884 identified some specimens from Queensland, under the name of *J. gemmacea*, and

remarked that the spicules are almost indistinguishable from those of *J. juncea*, while at the same time he expressed the opinion that *J. flexilis* Studer might not be a distinct species. The position of this species has already been discussed.

It would be useless to go in detail into all the records of this species; and in fact, it is very difficult to say whether the records of *J. juncea* and *J. gemmacea* are all correct in identification, as several authors do not mention whether their colonies were simple or branched. Another complication, however, creeps in. When fragments of colonies were examined, is it not possible that a branch of *J. gemmacea* might be referred to *J. juncea*, especially when we remember that the question of branching is the chief distinction between the two species?

Before going on to discuss the various characters of this species in detail, I would give the following quotation, as it is not only of great interest, but has apparently been overlooked by several authors in their identification of this species.

Ridley (1884) referred a colony from the N.-E. coast of Australia to the species *elongata*; but in 1887 (xxxii., p. 241) he replaced it in the species *gemmacea*, noting that he had overlooked the fact that *J. elongata* had no "clubs." He says:—"It will be seen that we probably have a very variable species before us, colour, form, and size being alike not to be depended on by themselves. The spiculation is fairly constant, but differs so little from that of the allied forms (*J. juncea* and *fragilis*) as to be scarcely a sufficient guide *per se* to the recognition of the species."

From the fact that the specimen referred to was dichotomously branched, I feel justified in recognizing it as *J. gemmacea*. An interesting feature about this specimen is the fact that when found it had been broken off at the base, and the broken part had been overgrown with coenenchyma, so that it had been living free in the water. An analogous state was observed in the case of a specimen of *Isis hippuris* Linn. in the Littoral Collection from the Indian Ocean.

In the Mergui Collection there is a large number of specimens of this species, and these are augmented by several from the Indian Ocean Collection from the Indian Museum, Calcutta. By means of these it has been possible to study and compare several characters which are very variable in a manner which would have been impossible with only a single or even a few specimens.

*Branching.*—The mode of branching is of the nature of a false dichotomy. The large main branches of the colony are again branched almost in one plane, but the general appearance of the colony is bushy.

The distance between branchings, though not constant, seems to increase from the base upwards, so that the longest unbranched parts are the terminal twigs. This is more marked in the taller colonies. In young dwarf specimens the relative distances between the origin of the several branches in ascending order is less pronounced, and the branches themselves are proportionately thicker. These latter specimens therefore have a different appearance from the older and more elongated colonies, but must be ranked in this species when we take into consideration the mode of growth, which will be discussed later.

Before doing so, however, it will be well to tabulate corresponding measurements in individual colonies, and see how far these give us a clue to the mode of growth. Fortunately we have in our possession intermediate stages which show the different developments during growth from the shortest to the tallest.

The following tables may serve to form a basis for such a study. In Table A the measurements are all given in centimetres. The symbol + indicates that the exact length is not known, owing to the basis of attachment having been broken off.

TABLE A.

Specimen.	Height.	Length of main stem.	Distance between branches.	Length of twigs.
I.	90	6	3-18	26
II.	80	12 +	2-10	28
III.	75	4 +	2-10	22
IV.	70	4 +	2-12	22
V.	65	5 +	2-12	16
VI.	62	5	2-11	15
VII.	55	4	2-9	16
VIII.	55	2 +	2-14	14
IX.	54	3 +	2-10	13
X.	53	8 +	3-10	14
XI.	44	7	2-10	12
XII.	42	3 +	2-7.5	13

Figures 15, 16, and 17 show the branching in the colonies, which have been proportionately reduced. The largest (fig. 10) was 800 mm. in length.

Let us consider two colonies which in general build are quite unlike one

another. The large specimen is from the Mergui Archipelago and the smaller is from the Andamans.

The former is 400 mm. in height; the latter is 230 mm. in height: the longest twig in the former is 220 mm., that in the latter 70 mm. The greatest distance between branchings in the former is 120 mm.; in the latter it is only 27.5 mm. So far, then, the measurements are proportionate; but when we take into consideration the corresponding diameters in the various parts, the difference is at once very marked. In the *smaller* colony the total diameter of the several branches and twigs is greater than in the larger; so that, at first, it is difficult to conceive that the dwarf colony could develop into a colony similar to the larger.

TABLE B.

Height of Colony.	Distance between branches.	Diameter of branches at origin.	Length of terminal twig.	Height of Colony.	Distance between branches.	Diameter of branches at origin.	Length of terminal twig.	Height of Colony.	Distance between branches.	Diameter of branches at origin.	Length of terminal twig.
	25				70	5			70	9	
	20				20	5.5			70	9	
	27.5				20	5.5			65	8	
	15	6.5			40	5.5			110	7	
230	25	6	70	440	45	5.5	120	700	100	6	220
	22.5	6			40	5.5			55	5	
	22.5	6			40	5			95	4.5	
	17.5	5.5			50	5			65	4	
	12	5.5			Twig	4.5			120	3.5	
	Twig	5							Twig	3	

Table B gives several measurements from three colonies of different sizes. One large branch has been selected and followed to the tip of the colony. The various lengths represent the consecutive distances at which branches arise from it. The first feature which may be seen from this Table is the fact that the distances at which the different branches arise do not increase proportionately from the base upwards. (2) Such increase as exists is more marked in the taller specimens. (3) In the very dwarf colony, the distances actually diminish in the upper half.

Let us now critically examine the measurements given in the same Table

of the diameters at the corresponding parts. (1) The diameters of the branches in the young colony are equal to, and, in some cases, greater than, corresponding measurements in the older colonies. The series of measurements of twelve specimens given in Table C shows that (1) the length of the main stem varies very little; (2) there is a distinct tendency towards an increase of length in the younger branches and twigs in the older specimens.

TABLE C.

Specimen.	Height in centimetres.	Breadth in centimetres.	MAIN STEM.			BRANCH.			TWIG.	
			Total diameter.	Diameter of axis.	Thickness of Coenenchyma.	Total diameter.	Diameter of axis.	Thickness of Coenenchyma.	Total diameter.	Thickness of Coenenchyma.
I.	90	20	9	8	0.5	4	2	1	2	1
II.	80	35	9	7.5	0.75	3.5	2	0.75	2	1
III.	75	24	9.5	8	0.75	4	2	1	2	1
IV.	70	18	9	8	0.5	3.5	2	0.75	2	1
V.	65	15	7.5	6	0.75	4	2	1	2	1
VI.	62	24	6	5	0.5	4	2	1	2	1
VII.	55	30	6.5	5	0.75	4	2	1	2	1
VIII.	55	23	6	5	0.5	4	2	1	2	1
IX.	54	20	7	5	1	4	2	1	2	1
X.	53	16	7	5	1	4	2	1	2	1
XI.	44	20	4.5	3	0.75	4	2	1	2	1
XII.	42	27	8	6	1	4	2	1	2	1

In Table C we have sought to analyse the nature of the constitution of the diameter—in other words, to find the actual proportion of axis and coenenchyma; and here several very interesting and useful facts have come to light.

- (1) The thickness of the coenenchyma at the tip of the twigs is almost a constant; in reality it is slightly thicker in the smaller specimens. It is noteworthy that the diameter of the axis at this part is negligible, being of a hair-like fineness.
- (2) Although the total diameter of branches lower down is greater than in the twigs, the actual thickness of the coenenchyma is never greater, and, in some cases, is actually less.

- (3) The thickness of the coenenchyma in the main stem is seldom as great as in the branches or twigs, and is usually from 0.75 to 0.5 times its thickness.

Bearing these facts in mind, let us see if any inference may be made as to the mode of growth, and also as to the possibility of these apparently diverse forms being referable to a single species.

- (1) We find that what obtains with regard to the various measurements in different parts of the same colony also holds good in the corresponding parts of colonies of different sizes.
- (2) It is also obvious that increase in thickness in the older parts of a colony is due, not to increase of thickness in the coenenchyma, but to increase in the diameter of the axis.
- (3) Increase in length in the younger branches and twigs is not proportional to increase in the thickness of the coenenchyma, but tends rather to the reverse of this situation.

We are therefore in a position to conclude that increase in the thickness of the coenenchyma is not proportionate to the age of the colony, but that the coenenchyma attains to its typical thickness at a very early stage, and that further elongation and consequent thickness are caused more by the growth of the axis than the coenenchyma; or, in other words, the earlier period of growth consists chiefly in development of the coenenchyma, while the strengthening of the axis and elongation of the colony come at a later period. Consequently the younger colonies are more bushy and fleshy, and the older colonies have proportionately a greater amount of axis, and are therefore more rigid.

The distribution of the polyps, the nature of the verrucae, and the details of the canal-system are exactly similar to those described for the protruding verrucae variety of *Juncella juncea*. Figs. 18 and 19 have been added to show the leading characteristics; and these should be compared with the corresponding figures (12 and 13) of *J. juncea*.

*Colour*.—The great majority of the specimens examined in this species are of a dark brick-red colour; but the following tints also occur:—(1) reddish orange, (2) brownish yellow, (3) orange-yellow, (4) lemon, and (5) creamy-white. There is thus almost a series of gradations from white through orange to red.

*Spicules of J. gemmacea.*

The spicules of this species, as has already been pointed out, are identical both in types and measurements with those of *J. juncea*, so that the description and measurements given for the latter may be taken as typical.

*Distribution of J. gemmacea.*

Red Sea.

Providence Island.

Mascarene Island, 19 fms.

Mermaid Straits.

Queensland, N.-E. Australia: Percy Island, 0-5 fms.; Port Molle, 12-20 fms. and between tide-marks; Port Denison, 4 fms.; Fitzroy Island, 11 fms.

Amirante Island, 32 fms.

Malacca.

Singapore.

King Island Bay, and elsewhere in the Mergui Archipelago, between tide-marks and up to 30 fms.

Torres Straits, 8 fms.

Gulf of Manaar.

Torres Straits (as *Ellisella maculata pars.*).

XII.—*Juncella racemosa*. Figs. 20-23.

*J. racemosa* Wright and Studer, l, p. 159, Pl. xxxiv, fig. 11.

*J. miniacea* Thomson and Henderson, xl, p. 81, Pl. v, figs. 7 and 12.

*J. racemosa* Thomson and Simpson, xli, p. 268.

This species was established by Wright and Studer for several small, delicate, branched specimens in the "Challenger" Collection, with the following features:—The branches arise all in one plane; in one specimen all the branches, to the very summit, are given off from the right side of the main stem, which is curved. Several of these are short and simple, while others are again branched. All the branchlets are given off from one side of the branch, and, when branched to a third degree, the same fact holds true. The polyps are numerous; and on the stem and branches they show an eight-rayed star; on further contraction, they appear as small papillae; when fully contracted, they are 1 mm. in height and 0.5 mm. in diameter. On one surface of the stem and branches polyps are absent; and on this naked portion a feebly marked groove winds up the stem. The polyps are much more numerous and crowded on the smaller branches, where they are placed in three or four rows. The colour of the coenenchyma and polyps varies from reddish yellow to dark red. The bases of the polyps and tentacles are of a much lighter hue. The coenenchyma is thin, and has the characteristic spicules of *Juncella*.

The figure of the spicules given in the "Challenger" Report (Pl. xxxiv., fig. 11) does not, however, give a good appreciation of their form; and this led

Thomson and Henderson to establish a new species (*J. miniacea*) for a small specimen from the Indian Ocean. The long spindles described for the latter species have since proved to be extrinsic.

An examination of the type specimen, and also of the spicules of *J. racemosa* in the British Museum, has proved beyond question that *J. miniacea* is not distinct from *J. racemosa*. This has already been pointed out (Thomson and Simpson, xli.) in connexion with another specimen which occurs in the collection of Littoral Alcyonaria of the Indian Museum, Calcutta (figs. 20, 21, and 22).

In the same collection, but hitherto undescribed, is a small portion of a delicate colony branched in one plane (fig. 21). The base is wanting; and what appears to be the main stem may be only a primary branch which has been broken off at the point of attachment of an acorn shell. It is 30 mm. in length, and is distinctly crescentic in shape. Five thread-like branches arise from the convex side, and one only from the concave. The longest of these is 55 mm.; and it is noteworthy that the branches are also curved. They in turn give origin to finer branchlets, which, with very few exceptions, arise from the convex side. Two acorn-shells have become attached to the colony; and these are overgrown with polyp-bearing coenenchyma; while one of them has given rise to a proliferation of the axis.

The coenenchyma is very thin; and it is impossible to discover the nature and number of the main canals.

The axis is thread-like, and is impregnated with lime.

The polyps are more scattered than in any of the previously described specimens, and stand almost perpendicularly. The arrangement of these is not easily determined. In the finer twigs they occur in two single rows (fig. 22); but the intrusion of young polyps and consequent development tend to obliterate this symmetry, and give an irregular arrangement.

The verrucae, when expanded, are cylindrical, and higher than broad; in this condition an eight-rayed structure is seen at the top. On contraction they become dome-like, and no trace of the rays is to be seen. The colour of the colony is a pale brick-red throughout.

The spicules are of the types characteristic of this species.

*Locality.*—Andamans.

*Diagnosis of J. racemosa.*

Colony delicate, branched in one plane; the branches tend to arise from one side of the stem, and the branchlets show a similar tendency; coenenchyma thin; polyps in the finer twigs and at the tips of the branches are usually disposed in two lateral rows; in the older parts of the branches

they occur irregularly over the coenenchyma. The verrucae, when expanded, are cylindrical, and either stand perpendicularly or are inclined upwards to the stem; when contracted they are low and dome-like. The spicules are very minute, and are distinctly prickly in appearance (fig. 23). The following types may be distinguished:—

- (a) *Slender clubs*, with a distinct smooth middle portion, surmounted by a spiny head, only slightly thicker than the constriction.
- (b) *Short, stumpy clubs*, much broader in proportion to their length, and with the spines slightly more divaricate.
- (c) *Double wheels*, with an elongated hub.
- (d) Elongated forms, with a distinct smooth constriction, which may be conveniently termed *double spindles*.
- (e) Occasional *quadriradiates*.
- (f) *Needles* in the anthocodiae.

The following may be taken as typical measurements in millimetres as they occur in all the specimens so far known:—

(a)	0.076 × 0.031	constriction	0.008 × 0.008.
	0.065 × 0.031	„	0.011 × 0.008.
	0.065 × 0.023	„	0.008 × 0.008.
(b)	0.053 × 0.034	„	0.008 × 0.009.
	0.053 × 0.031	„	0.011 × 0.008.
	0.049 × 0.031	„	0.008 × 0.008.
(c)	0.057 × 0.027	„	0.011 × 0.008.
	0.051 × 0.027	„	0.011 × 0.009.
	0.046 × 0.027	„	0.008 × 0.008.
(d)	0.076 × 0.027	„	0.011 × 0.008.
	0.068 × 0.027	„	0.011 × 0.011.
	0.061 × 0.031	„	0.008 × 0.008.
(e)	0.038 × 0.034		
(f)	0.1 × 0.04, 0.06 × 0.04		

*Colour-schemes*—Brown throughout.

Vermilion-red.

Orange-red, with tips of the verrucae yellow.

Pale brick-red.

*Localities*.—Hyalonema-ground, off Japan, 345 fms. (Wright and Studer).

Andamans, 120 fms. (Thomson and Henderson).

Andamans, „ (Thomson and Simpson).

Andamans, „ (as stated above).

XIII.—*Juncella trilineata*. Figs. 24–26.

*Juncella trilineata* Thomson and Henderson, xxxix., p. 315.

In 1905 Thomson and Henderson established this very characteristic species, of which the following notes are of particular interest. The specimen was sparingly branched. "The polyps arise in three different bands, leaving three narrow, bare strips, each of which has in its centre a bare rib or keel. Under each bare strip lies a large longitudinal canal."

Only one specimen of this remarkable form has so far been described; it was obtained at Patani, Siam.

The spicules are of the *Juncella* type, and are hardly distinguishable from those of *J. juncea*. Very characteristic, however, is the presence of three main canals situated symmetrically around the axis. The result of this on the external appearance is that there are three longitudinal spaces on the coenenchyma devoid of polyps; the verrucae are therefore disposed in three longitudinal groups, and this arrangement is unique amongst Juncellids.

"The polyps, which measure from 1.1 mm. to 1.5 mm. in height, are arranged in transverse rows of 3–4; but many smaller polyps occur which break this regularity."

For a short distance from the end of the branches the polyps occur in three single rows (fig. 24); but passing downwards two, three, four, or more are to be seen, and scattered among these are immature forms, so that all that can be said with regard to the disposition of the polyps is that they occur in three longitudinal groups, the exact number in a transverse row depending on the position in the colony and on its stage of development.

The coenenchyma is of the typical Juncellid type; it consists of an outer non-canal-bearing part and an inner canal-bearing part. These are separated by a concentric series of outer longitudinal canals. In the inner series of longitudinal canals which separate the coenenchyma from the axis there are, however, three much larger than the rest; these correspond to the three longitudinal tracts devoid of polyps and separate off the three polyp-bearing ridges (fig. 25).

In the Indian Ocean Littoral Collection there occurs a small, simple colony, 5.5 mm. in height and 2.5 mm. in maximum diameter. The attachment has been broken off, but has evidently not been far from the present base. For a short distance from the base there is a portion devoid of polyps. Throughout the remainder of the colony the polyps seem to be arranged in three irregular longitudinal series, and as a cross-section reveals what are evidently the main canals, we feel justified in referring the specimen to this

species. The verrucae are about 1 mm. in height, but are not so densely packed as in the type-specimen (fig. 24); but this may be due to its immature condition.

The colour is orange-yellow, but the verrucae are paler.

*Locality*.—Off Ceylon, 34 fms.

*Diagnosis of J. trilineata.*

Colony upright, sparingly branched, the branches long and slender. Very characteristic is the presence of *three* main longitudinal canals and the consequent disposition of the polyps in *three* longitudinal groups. The verrucae may show the different stages characteristic of the genus. The following types of spicules may be distinguished (fig. 26).

(a) Slender clubs, with a distinct central bare portion; the knobs on the handle stand almost perpendicularly; the projections on the club-portion arise at a slight angle and are directed downwards.

0.068 × 0.019 length of constriction 0.017.

0.068 × 0.017 " " 0.017.

0.068 × 0.019 " " 0.015.

(b) Clubs, similar to (a), but thicker in proportion to their length.

0.072 × 0.038 length of constriction 0.018.

0.068 × 0.034 " " 0.017.

(c) Double-stars, with very few large smooth warts at each end.

0.076 × 0.038 constriction 0.019 × 0.015.

0.066 × 0.042 " 0.015 × 0.015.

0.061 × 0.034 " 0.015 × 0.012.

(d) Double-wheels.

0.065 × 0.034 constriction 0.015 × 0.014.

*Colour*.—Dark red.

*Localities*.—Patani, Siam. Off Ceylon, 34 fms.

XIII A.—APPENDIX TO JUNCCELLA.

"*Incertae Sedis*."

*Juncella santae-crucis*.

1. *Juncella santae-crucis* Duch. and Mich., v., p. 21, t. 2, f. 1.

2. *Juncella viminella* (?), *santae-crucis* Gray, xii., p. 29.

1. "Polypario stirpe simplici, rigido; axe terete, lutescente, gracili; cortice cretaceo, albo; calycibus irregulariter biseriatis, inaequalibus, nempe nunc majoribus nunc duplo minoribus; ore terminali, parvo, radiato."

"The polyps are irregularly disposed in a double row on each side of the colony; there is a median bare space on each side of the two flattened faces. The verrucae are unequal in height, and stand at right angles to the colony; they are conical in shape; the summit has a small opening which shows a radiated structure."

Duchassaing and Michelotti had, however, only a fragment devoid of base; the breadth was 5.5 mms., including the verrucae, the longest of which were two mms. in height.

2. Coral simple, rigid; axis cylindrical, yellowish, slender; bark cretaceous, white; cells irregularly disposed in a double row on each edge of the stem, unequal; some twice as large as the others, smooth, terminal, small, and radiated; lateral area flat and naked, with a central groove.

*Locality*.—Island of St. Croix (West Indies).

#### ***Juncella funiculina*.**

*Juncella funiculina* Duch. and Mich., v., p. 22, Pl. VII., figs. 9 and 8.

Colony simple, flexible; polyps in a single series on two sides, small, adpressed to the stem, and directed upwards; oval opening small, with a radiate structure; coenenchyma thin, white; axis yellowish.

*Locality*.—Guadaloupe.

#### ***Juncella barbadensis*.**

*Juncella barbadensis* Duch. and Mich., p. 22, Pl. v., figs. 5 and 6.

Colony attached, simple, filiform, white; polyps elongated with club-shaped spicules; verrucae in a single series on each side; there is a distinct median groove on each bare space. It is larger and more robust than *J. funiculina*; the verrucae are larger.

*Localities*.—Barbadoes and Guadaloupe.

#### ***Juncella calyculata*.**

*Gorgonia calyculata* Ellis and Solander, vi., p. 95.

*Juncella calyculata* Valenciennes, xlv.

*Gorgonella calyculata* Kölliker, xxiii., p. 140.

*Ellisella calyculata* Gray, ii., p. 26.

Ellis and Solander's description is as follows :—

This Gorgon grows in a sub-divided order, having erect, thick branches with truncated papillae. The flesh is ash-coloured without, and purple on the inside, furnished with large, cup-shaped mouths, disposed close together in a quincunx order, and looking upwards, having polyps with eight fringed claws extending themselves from them. The bone is of a dark-brown

colour and horny nature. This sea-shrub sends forth round white eggs, larger than any of the genus.

*Locality*.—Isle of Bourbon.

***Juncella hystrix*.**

*Juncella hystrix* Valenciennes, Comptes Rendus, xli., p. 14.

*Juncella hystrix* Milne-Edwards and Haime, Corall., i., p. 186.

*Juncella hystrix* Johnson, xix., p. 143.

*Juncella hystrix* Johnson, xviii., p. 506.

The only description of any importance of this species is as follows :—  
Stem delicate. Verrucae markedly projecting.

*Locality*.—Bahia.

***Juncella vimen*.**

*Juncella vimen* Valenciennes, Comptes Rendus, xli., p. 14.

*Juncella vimen* Milne-Edwards and Haime, Corall., i., p. 186.

Milne-Edwards and Haime describe this species thus :—

Verrucae disposed laterally in such a manner that a large distinct non-polyp-bearing median space is left.

*Locality*.—Isle of Bourbon.

***Juncella surculus*.**

*Juncella surculus* Johnson, xviii., p. 506.

*Juncella surculus* Johnson, xix., p. 143.

*Locality*.—Senegal.

***Juncella laevis*.**

1865. *Juncella laevis* Verrill, xlviii., 1865, p. 189.

1870. *Juncella laevis* Gray, xii., p. 29.

Verrill's original description is as follows :—

“Corallum tall, simple, subcylindrical, rather slender, diminishing in size both at the summit and near the base, where the polyps become obsolete. Cells adpressed, scarcely prominent, arranged in two broad bands, leaving a narrow, median, naked space on each side, along which there is a well-marked groove; they are placed alternately, at a distance of about one-fifth ( $\cdot 2$ ) inch, in about six vertical rows on each side, producing a quincunx arrangement; axis slender, cylindrical, calcareous, white, surrounded by about sixteen longitudinal lobes, two of which are larger and correspond with the lateral grooves; the others to the rows of polyps. Length of the single specimen, imperfect at each end, 20 inches; greatest diameter,  $\frac{1}{4}$  ( $\cdot 25$ ) inch. Colour yellowish-brown, in alcohol.”

*Locality*.—Hong-Kong, China.

Gray (xii., p. 29), not having seen the specimen, simply recapitulates the above description.

***Juncella extans*.**

*Juncella extans*, Verrill, xlvii., p. 37.

"Tall and simple, with the very prominent verrucae curved inwards, and arranged crowdedly in a band on each side of the axis, leaving a wide, naked space on each side. Colour white. Axis greyish-white, stony, and rigid."

*Locality*.—Fayal, Azores.

**XIV.—*Scirpearia* emend.**

(a) *Discussion of the Genus.*

1830 *Scirpearia*, Cuvier, i. p. 319.

1878 *Scirpearia*, Studer, xxxiv., p. 660.

1887 *Scirpearia*, Studer, xxxv., p. 67.

1901 *Scirpearia*, Studer, xxxvii., p. 52.

1889 *Scirpearia*, Wright and Studer, l., p. lxx.

1889 *Scirpearia*, Wright and Studer, l., pp. lxx and 154.

1855 *Ctenocella*, Valenciennes, xlv., p. 14.

1857 *Ellisella*, Gray, x., p. 287.

This genus was established by Cuvier in 1830 to include *Pennatula mirabilis*, but the following note may be interesting:—Milne-Edwards and Haime (Hist. Nat. Corall., l. 0. 214) say: "The Alcyonarian described and figured by Cuvier under the name *Pennatula mirabilis* seems to be very little connected with *Virgularia mirabilis*, as some have suggested. It has a slender stem attenuated at the two extremities, and bearing at each side a simple series of widely separated polyps. Cuvier formed of it the genus *Scirpearia*, which has been adopted by Ehrenberg. Lamarck placed it in his genus *Funiculina*, near *Pavonaria*, under the name of *Funiculina cylindrica*. Fleming thought that the species was not distinct from *Virgularia*; and Blainville affirmed that it was nothing but a *Gorgonia*. None of these opinions seem to me admissible. It is too imperfectly known to have a place assigned to it in a scientific classification of corals."

In 1878 Studer resuscitated the genus, and gave the following diagnosis:—"Colony simple or branched; axis cylindrical, horny, and calcareous; coenenchyma thin; calyces projecting; in two longitudinal rows on the sides of the stem and branches; spicules double-clubs and spindles."

This, then, must be our starting-point in generic determination.

In 1901 he re-united under the name of *Scirpearia* all the Gorgonellids with a simple, flagelliform colony which have large verrucae in the form of clubs, and whose spicules are double-clubs and spindles. The coenenchyma is thick and the colony is bilaterally symmetrical. The polyps are disposed on two sides of the axis.

Wright and Studer in 1889 give the following diagnosis:—"Colony simple with a cylindrical calcified axis and thin coenenchyma. The polyps are seated in two longitudinal rows on each side of the stem. The spicules are double-clubs and spindles. The genus may include *Scirpearia mirabilis* Cuvier and *Viminella flagellum* Gray."

It must be remembered, however, that in the same memoir they separated off the genus *Scirpearella* as follows:—"Colony simple or very feebly branched. Axis calcareous, brittle, smooth, or grooved. Polyps arranged in rows or spirals, retractile, with more or less prominent verrucae. Coenenchyma is moderately thick and finely granular. The spicules are spiny spindles and double-clubs.

We have already shown, however, that such a distinction cannot be said to obtain, and have already proposed the uniting together of *Scirpearia*, *Scirpearella*, *Ellisella*, and *Ctenocella*, and have given an emended diagnosis.

In this emended sense, then, we now proceed to classify specimens with these characters into different species.

Before doing this, however, it might be well to give the following list of the various species which have, from time to time, been referred to the genus under consideration, under the names *Scirpearia*, *Scirpearella*, *Ctenocella*, and *Ellisella* :—

- Scirpearia flagellum.*
- Scirpearia furcata.*
- Scirpearella profunda.*
- Scirpearella gracilis.*
- Scirpearella rubra.*
- Scirpearella indica.*
- Scirpearella aurantiaca.*
- Scirpearella alba.*
- Scirpearella divisa.*
- Ellisella maculata.*
- Ellisella calamus.*
- Ellisella coccinea.*
- Ellisella elongata.*
- Ctenocella pectinata.*

Some of these—e.g., *flagellum* and *elongata*—have, at times, appeared under other generic names; but these will be discussed later under the species in question.

(b) *Classification of the Species.*

In formulating a scheme of classification for these different species, and also the large number of undescribed specimens which I have before me for identification, two courses were available, either (1) to describe every individual specimen, and name it on account of certain differences which may or may not be inherent, or (2) to study the group as a whole, tabulate all the points of difference in the various specimens, eliminate all variations, such as occur in the same colony, reject all environmental modifications, and arrange the specimens around some central type. The latter plan has been adopted in the present work; and for this reason it has been necessary to abolish several of the previously described species, not on account of their absolute identity with formerly described species, but on account of the differences which obtain in these different forms having proved to be not greater than differences appearing in an individual specimen. A very good example of this is seen in the case of *Scirpearia furcata*. Such a procedure has been possible in the case under consideration only on account of the large number of specimens which it has been my privilege to examine; and it is more than probable that when a larger mass of material is available, it may still be possible to diminish the number of species in this report.

The characters on which the present classification are based are the following:—

- (1) the number of main longitudinal canals,
- (2) the nature of the spiculation, and
- (3) the nature of the branching.

These, of course, are not all of equal value; but a *very rigid separation* may be made into two classes based on the number of main longitudinal canals. It has been found that in this group specimens have either *two* or *four* main canals.

The nature of the branching when it comes to be a question of "simple or branched," as we have already pointed out, is of little value except in certain well-defined species. This is very evident in such colonies as those described under *Scirpearia furcata*. On the other hand, the very characteristic mode of branching seen in *Scirpearia pectinata* would seem to justify its inclusion as a specific character.

*Scirpearia andamanensis* and *Scirpearia ramosa* are also worthy of consideration in this respect.

The nature of the spiculation is also a character on which great reliance may be placed as a specific determinant; and, in the case of *Scirpearia*, it has proved to be of great value.

Very good examples of this may be seen in the great contrast between the spicules of *Scirpearia profunda* and *Scirpearia alba*, or between *Scirpearia flagellum* and *Scirpearia ramosa*, or between *Scirpearia furcata* and *Scirpearia thomsoni*.

By means, then, of a combination of these characters, it has been possible to arrange the numerous specimens which have been examined into certain fairly definite groups. It will be seen that in the great majority of cases each group is represented by a single species; but where possible we have suggested affinities. It seems preferable, however, to designate these at present as groups rather than as species, although the latter procedure must also be used for reference.

It is unnecessary to enter into the details of each group here, as that is much better left over until the various specimens are discussed; but we submit the following classification:—

#### SCIRPEARIA.

##### DIVISION 1.—*Main Longitudinal Canals, TWO in number:—*

- (a) profunda-group, . . . *Scirpearia profunda* emend.
- "                  . . . *Scirpearia hicksoni* n. sp.
- "                  . . . *Scirpearia verrucosa* n. sp.
- "                  . . . *Scirpearia anomala* n. sp.
- (b) pectinata-group, . . . *Scirpearia pectinata* emend.
- (c) elongata-group, . . . *Scirpearia elongata* emend.
- (d) flagellum-group, . . . *Scirpearia flagellum* emend.
- (e) thomsoni-group, . . . *Scirpearia thomsoni* n. sp.
- (f) alba-group, . . . *Scirpearia alba* emend.
- (g) aurantiaca-group, . . . *Scirpearia aurantiaca* emend.
- (h) furcata-group, . . . *Scirpearia furcata* emend.
- (i) andamanensis-group, . . . *Scirpearia andamanensis* n. sp.
- (j) ramosa-group, . . . *Scirpearia ramosa* n. sp.
- (k) ceylonensis-group, . . . *Scirpearia ceylonensis* n. sp.
- (l) maculata-group, . . . *Scirpearia maculata* emend.

##### DIVISION 2.—*Main Longitudinal Canals, FOUR in number:—*

- (a) quadrilineata-group, . . . *Scirpearia quadrilineata* n. sp.

*Profunda-group.*

This group is characterized by the enormous size of the spicules. The two chief types which occur are:—

- (1) Double-clubs with almost hemispherical ends, and
- (2) Elongated double-clubs, which approach double-spindles and even spindles.

Four species may be recognized:—

1. *Scirpearia profunda* Wright and Studer *emend.*
2. *Scirpearia hicksoni* n. sp.
3. *Scirpearia verrucosa* n. sp.
4. *Scirpearia anomala* n. sp.

The following differential diagnosis of the spicules of these four species may be useful:—

***Scirpearia profunda* (emend.).**

In this species the spindle-type predominates over the elongated double-club. The spindles are massive, very warty, and irregular in outline (fig. 27). Typical measurements are  $0.122 \times 0.057$ ;  $0.114 \times 0.049$ ; and a more slender type  $0.106 \times 0.034$ ;  $0.09 \times 0.034$ . The double-clubs have almost hemispherical ends, and have practically no constriction,  $0.084 \times 0.046$ ;  $0.08 \times 0.053$ .

***Scirpearia hicksoni* n. sp.**

The spicules of this species are very regular in outline; they are covered with slightly papillose warts; and the elongated double-clubs have extremely blunt ends (Fig. 31).

- (1) double-clubs:— $0.08 \times 0.05$ ;  $0.075 \times 0.05$ .
- (2) Elongated double-clubs:— $0.11 \times 0.045$ ;  $0.085 \times 0.035$ .

***Scirpearia verrucosa* n. sp.**

In this species the spicules are very irregular in outline; they are covered with long papillose warts, which are widely separated. The ends of the elongated double-clubs and double-spindles are markedly pointed, and have the form of elongated cones (fig. 33).

- (1) Double-clubs:— $0.095 \times 0.05$ ;  $0.07 \times 0.04$ .
- (2) Elongated double-clubs.— $0.14 \times 0.04$ ;  $0.11 \times 0.02$ .

***Scirpearia anomala* n. sp.**

The spicules of this species are not densely covered with warts, and the warts themselves are only slightly papillose. The ends of the elongated double-clubs and double-spindles are markedly conical (fig. 35).

- (1) Double-clubs:— $0.061 \times 0.042$ ;  $0.06 \times 0.04$ .
- 2) Elongated double-clubs:— $0.15 \times 0.034$ ;  $0.095 \times 0.046$ .

XV.—*Scirpearia profunda* (Wright and Studer). Fig. 27.

*Scirpearella profunda* Wright and Studer, l., p. 155, Pl. xxxi., fig. 2;

Pl. xxxii., figs. 1 and 1a; Pl. xxxiv., fig. 7.

*Scirpearella gracilis* Wright and Studer, l., p. 156, Pl. xxxi., figs. 1 and 1a;

Pl. xxxiv., fig. 6.

*Scirpearella rubra* Wright and Studer, l., p. 157, Pl. xxxiv., fig. 5.

*Scirpearella moniliforme* Thomson and Henderson, xl., p. 82.

We have examined the type specimens in the British Museum of these three species, and have come to the conclusion that they cannot be regarded as distinct. *S. rubra* is undoubtedly the same as *S. gracilis*; but *S. profunda* differs in that it is branched. When we take into consideration, however, the great length of the flagelliform branches of *S. profunda*, we are quite in a position to conceive the longest fragment of *S. gracilis* as a portion of a branch of a much larger colony than that formed by *S. profunda*. These two species, as Wright and Studer observe, "were taken at the same haul of the dredge from a depth of 130 fms.; although, no doubt, closely related forms, there seem sufficient differences to justify their being for the present treated as distinct."

The spiculation is essentially the same in all three species; and the nature and distribution of the verrucae show variations not greater than those in other cases of specimens undoubtedly belonging to the same species. For this reason we feel justified in merging the three species under the earliest name, *S. profunda*.

The following are the chief characteristics of the different types:—

*S. profunda*.—The colony is feebly branched. The axis is calcareous, brittle, and of a circular outline, with some spiral grooves; it is formed of several concentric calcareous layers, which easily peel off.

The polyps are in irregular spirals on the stem and branches, from 2 mm. to 3 mm. apart, but closer to one another towards the termination of the branches. The older verrucae are more conical than the younger ones. When fully retracted they are oblong conical.

The coenenchyma is moderately thick and finely granular.

The colour in spirits is a whitish-brown.

*Locality*.—"Challenger" Station 177, off the New Hebrides; depth, 130 fms.; bottom, volcanic sand.

*S. gracilis*.—Colony is simple, so far as can be judged.

The axis is calcareous and very brittle; it is grooved. The polyps are crowded on the stem in four rows, the polyps in one row alternating with those in the next row, so as to give a more or less spiral arrangement to the

polyps colony. This arrangement is sometimes obscured by the addition of young polyps between the older ones. Towards the apex of the stem the polyps are in three rows, and at the very apex they are opposite. When withdrawn the verrucae are nipple-like.

The coenenchyma is moderately thick.

*Locality*.—"Challenger" Station 177, off the New Hebrides; depth, 130 fms.; bottom, volcanic sand.

*S. rubra*.—Colony simple (not complete), but 620 mm. in length. The axis is calcareous, brittle, with two shallow grooves.

The polyps are numerous, arranged in spirals on the stem. Towards the termination of the axis they are disposed in an alternate manner on the opposite sides of the stem.

The coenenchyma is thin, with a compact layer of spindles and warty clubs.

The colour in spirits is light red.

*Locality*.—"Challenger" Station 232, Hyalonema ground, off Japan; 345 fms.; bottom, green mud.

*S. moniliforme* Thomson and Henderson is also referable to this species.

*Locality*.—Eight miles west of Interview Island, Andamans; 270-45 fms.

From the foregoing it is obvious that, except in the question of branching—a character to which very little importance can be attached, since the specimens are nearly all incomplete—the macroscopic structure shows a range of variation, such as we expect to find in long flagelliform colonies. For this reason it is impossible to consider the question of different species on these characters alone. Preparations of spicules from corresponding parts of the different colonies show no great disparity either in the types themselves or in the characters and measurements of the types, so that we are forced to rank these different specimens as one variable species having a type of spiculation different from others known at present.

Amongst the numerous undescribed specimens which have been examined in the preparation of this memoir none were found to agree with the "Challenger" forms; but this fact may not be considered remarkable when we take into consideration the localities from which they were obtained.

The spicules of this species are large and very characteristic (fig. 27 *a-g*). They consist of large warty spindles, some of which show a trace of a constriction. Two forms of these may be recognized—(*a*) slender and very warty, and (*b*) more massive spindles. In addition to these, the most definite type is the large double-club; these have very massive warty ends, and practically no constriction, and some have more hemispherical heads than the

others (*c*). These three types may be regarded as characteristic; but other forms occur—e.g. irregular forms (*d*): double-wheels (*e*), crosses (*g*).

The irregular forms (*d*) show variations which might be regarded as departures from double-clubs or from the massive spindles, and may be intermediate between the types (*b*) and (*c*). In the same way those represented by (*f*) may be looked upon as annectant forms between types (*e*) and (*g*).

The crosses (*g*) show great variation.

The following measurements in millimetres may be taken as typical:—

- (*a*) Spindles, slender and very warty:  $0.106 \times 0.034$ ;  $0.103 \times 0.30$ ;  $0.09 \times 0.034$ .
- (*b*) Spindles, very warty and massive:  $0.122 \times 0.057$ ;  $0.118 \times 0.057$ ;  $0.114 \times 0.049$ .
- (*c*) Double-clubs, with massive warty ends and practically no constriction;  $0.084 \times 0.046$ ;  $0.072 \times 0.046$ ;  $0.08 \times 0.053$ .
- (*d*) Irregular forms:  $0.095 \times 0.053$ ;  $0.095 \times 0.046$ ;  $0.076 \times 0.053$ .
- (*e*) Double-wheels, a few:  $0.072 \times 0.034$ ;  $0.057 \times 0.027$ .
- (*f*) Crosses:  $0.11 \times 0.076$ ;  $0.084 \times 0.061$ ;  $0.061 \times 0.034$ .

#### *Emended Specific Diagnosis.*

The colony is simple and feebly branched; in the latter case the branches are long and flagelliform. The axis is calcareous and brittle; it is composed of concentric layers; the surface is marked by longitudinal grooves; sometimes two of these are deeper than the others. The polyps are disposed in two longitudinal series; this arrangement may be obscured in the older parts; and then the disposition may simulate a spiral. Near the base four rows may occur in each series; but this number diminishes in the younger parts, so that near the tip there is only a single row, alternately on opposite sides. The verrucae when partially retracted are conical, but when more fully withdrawn are nipple-like. The canal-system is typical. The coenenchyma is moderately thin and finely granular. The spicules are characterized by the presence of large, thick, warty spindles longer than the large double-clubs.

#### XVI. *Scirpearia hicksoni*, n. sp., figs. 28–31.

It has been found necessary to establish a new species for two portions of what must have been a very long, simple colony; they are not continuous, however; and judging from the difference in the diameter of the axis in the two parts an intermediate piece of considerable length must have been lost. The base is wanting, and this must also have been some distance from the

present basal part, so that the colony when complete must have been of great length.

The lower of the two parts under examination is 18 cm. in length, the upper part, which bears the tip of the colony, is 15 cm. The axis at the present base is 2.5 mm. in diameter, and tapers after 18 cm. to 2 mm. In the upper portion the axis tapers from 1.5 mm. to a fine point. Thus we see that the part of the colony having an axis varying from 2 mm. to 1.5 mm. is wanting; and this at the lowest estimate cannot have been less than 18 cm.; so that, without taking into account the basal part, the colony could not have been less than 50 cm. In all probability the total length would have exceeded 70 cm., so that we are dealing with a very long, simple flagelliform colony.

The surface of the coenenchyma is coarsely granular, and, especially on the verrucae, there are numerous ridges formed by aggregations of spicules (cf. *Suberogorgia ornata*, Thomson and Simpson). The coenenchyma proper is extremely thin; but the large size of the verrucae renders this feature less evident.

The general colour of the colony is brick-red; but where the anthocodiae are not retracted they appear as white specks on the tips of the verrucae.

The polyps have a very characteristic arrangement; but this cannot be regarded as specific, as it is only superficial, and may have been caused during the process of killing.

In the lower portion of the colony about one-third of the surface is bare; and the verrucae seem to arise in the same plane on either side, and are continuous with it (fig. 28). This, of course, causes a crowding on the other two-thirds. On the side diametrically opposite the above bare space there is also a tract devoid of polyps (fig. 29). In the upper portion this arrangement is still visible; towards the tip of the colony, however, the polyps seem to be distributed all round the coenenchyma; but a trace of the bilateral arrangement is still discernible (fig. 30).

The verrucae are large and have the form of truncated cones; they stand perpendicularly to the coenenchyma. The largest are 4 mm. in height and 2.5 mm. in diameter at the base; but towards the tip of the colony they are only 2.5 mm. in height and 1 mm. in diameter.

The larger of the verrucae are markedly conical; but the younger forms are very much flattened owing to the contraction of the thin walls; they are then less definite in position; and many have their tips either incurved or directed upwards. When partially retracted they have a very marked eight-rayed structure at the summit, and show eight to twelve longitudinal ridges formed by segregations of spicules.

The anthocodiae are very minute; the tentacles are short and white, and bear one row of pinnules. They are first infolded, and then the tip of the verruca is introverted.

The canal system is typical; and the two main canals are evident in a cross-section, corresponding to the two bare spaces. There is no inequality in their size, so that we are justified in concluding that the apparent arrangement of the polyps is due to contraction while killing.

The axis is cylindrical and very densely calcareous; it is composed of concentric laminae. Near the base it is dark brown in colour; but in the younger part it is of a golden-yellow hue. The surface is marked with irregular longitudinal striae which correspond to the inner series of canals. There is no suggestion of two depressions larger than the others.

The spicules of this species are very characteristic (fig. 31). They are very regular in outline, and are covered with warts, which are slightly papillose at the summit. The elongated double-clubs are extremely blunt at the ends.

The following are the chief types, with measurements, length by breadth, in millimetres:—

- (a) Large double-clubs with a short broad constriction. The ends are almost hemispherical; the warts are few in number, large and papillose:  $0.08 \times 0.05$ ;  $0.075 \times 0.055$ ;  $0.075 \times 0.05$ .
- (b) Smaller double-clubs very similar to the above:  $0.06 \times 0.03$ ;  $0.05 \times 0.025$ .
- (c) Elongated double-clubs with round ends. In some of these the constriction is very marked, while in others it is hardly visible, so that this type passes through double-spindles to simple-spindles. They are covered with few, large, papillose warts:  $0.11 \times 0.045$ ;  $0.11 \times 0.035$ ;  $0.1 \times 0.04$ ;  $0.085 \times 0.035$ ;  $0.07 \times 0.02$ .

*Locality*.—Andamans, 36 fathoms.

#### XVII.—*Scirpearia verrucosa* n. sp. Figs. 32 and 33.

In the Indian Museum Littoral Collection there occurs a complete simple flagelliform colony, 27 cm. in length, attached to a piece of shell, for which the establishment of a new species has been necessary. The coenenchyma is very thin, and the surface is granular; its maximum thickness is about 0.75 mm.

The general colour of the colony is salmon-pink; but the anthocodiae and the tips of the verrucae, when only slightly retracted, are white. The distribution of the polyps is identical with that in *Scirpearia hicksoni* n. sp.

The lower 4 cm. bear no polyps; this is followed by two bare tracts which diminish to two distinct lines from which the verrucae diverge at acute angles.

The verrucae have the form of truncated cones; but the walls are very thin, and even near the base they have collapsed, and present the appearance of those near the tip in the previous specimen. Throughout the whole of the colony they are directed slightly upwards (fig. 32), and the tips are incurved; this is more marked towards the apex. Near the growing point they are wart-like. The largest of the verrucae are 2.5 mm. in height and about 1.5 mm. in diameter at the base.

The canal system is identical with that described in the previous specimen.

The axis is cylindrical, but tapers slightly towards the tip; it is greenish brown near the base, but becomes pale yellow in the younger portion. It is not very calcareous, and the surface has only very indefinite longitudinal striae.

The spicules (fig. 33) of this species are extremely characteristic; they are covered with long papillose warts, which are for the most part widely separated, and so give a very irregular outline to the spicules. The ends of the elongated double-clubs and double-spindles are markedly pointed, and have the form of elongated cones.

The following are the chief types, with measurements, length by breadth, in millimetres:—

- (a) Double-clubs with a short, broad constriction, with almost hemispherical ends and with large, slightly papillose warts:  $0.095 \times 0.05$ ;  $0.09 \times 0.045$ ;  $0.08 \times 0.05$ ;  $0.07 \times 0.04$ .
- (b) Elongated double-clubs approaching double-spindles and even-spindles; these have markedly conical ends; the constriction may be more or less definite; and they are covered with relatively distant, long, papillose warts:  $0.114 \times 0.04$ ;  $0.13 \times 0.035$ ;  $0.11 \times 0.03$ ;  $0.11 \times 0.02$ .

*Locality*.—Andamans Sea, 55 fms.

#### XVIII.—*Scirpearia anomala* n. sp. Figs. 34 and 35.

This species has been established for a small, complete, simple colony in the Littoral Collection of the Indian Museum. It is 17 cm. in length, attached to a piece of decayed shell which is overgrown with Polyzoa and worm-tubes. The diameter of the colony near the base is 1.75 mm.; midway it is 2 mm., while near the apex it is 1.5 mm.; so that there is only a slight gradation.

The coenenchyma is moderately thin and finely granular; the general colour of the colony is orange-yellow; but the verrucae are reddish.

The polyps are confined to two longitudinal, lateral tracts, separated by two bare spaces. Near the base of the colony, and also in the younger part near the tip, there is a single row of polyps in each series; but in the middle part there are two irregular rows, owing to crowding and the interposition of young polyps.

The verrucae, when only partially retracted, are cylindrical, elongated, and slightly turned towards the coenenchyma (fig. 34*b*). Near the base (fig. 34*a*) and the tip (fig. 34*c*) they are almost completely retracted, and then appear as low warts, and may even be sunk within pits in the coenenchyma. The great majority of the verrucae are directed upwards, but some are turned downwards. When expanded they are about 1.25 mm. in height and 1 mm. in diameter at the base.

The canal system is typical; the two main longitudinal canals are only slightly larger than the others.

The axis is cylindrical, tapers only slightly, and is calcareous. The colour varies from brown to yellow; the surface is marked by faint longitudinal striae.

The spicules of this species (fig. 35) are very characteristic. They consist of double-clubs, double-spindles, and some which approach spindles. They are not densely covered with warts; while the warts themselves are only slightly papillose.

The following are the chief types, with measurements, length by breadth, in millimetres:—

- (a) Small double-clubs, with almost hemispherical ends, and irregularly covered with small papillose warts and with a short, broad constriction:  $0.061 \times 0.042$ ;  $0.06 \times 0.04$ .
- (b) Slightly elongated double-clubs very openly warted and with relatively blunt ends:  $0.11 \times 0.06$ ;  $0.095 \times 0.046$ ;  $0.099 \times 0.049$ .
- (c) More elongated double-clubs, approaching double-spindles and even spindles. The ends are markedly conical, and the constriction is more or less definite:  $0.015 \times 0.034$ ;  $0.08 \times 0.03$ .

*Locality*.—Andamans.

#### PECTINATA GROUP.

This group is easily distinguished by the character of the spiculation, but also, and more readily, by its unique type of branching.

XIX.—*Scirpearia pectinata* emend. Figs. 36–45.

<i>Keratophyton seba</i>	Thesaurus, t. 111, p. 193, Pl. cv., fig. 19.
<i>Gorgonia pectinata</i>	Pallas, xxvii., p. 224.
" "	Pallas, xxviii., p. 179.
" "	Lamarek, xxiv., t. 11, p. 320, et 2nd edit., p. 498.
<i>Pterogorgia</i>	" Dana, cxi., p. 652.
<i>Ctenocella</i>	" Valenciennes, xlv., p. 14.
" "	Milne-Edwards and Haime, xxvi., t. 1, p. 185.
" "	Ridley, xxxiii., p. 348.
" "	Studer, xxxvii., p. 119.
<i>Gorgonella</i>	" Köl liker, xxiii., p. 140, Pl. xviii., fig. 41.

This species, as we have already pointed out, is the sole representative of the genus formerly known as *Ctenocella*; so that the diagnosis of that genus in the early records summarizes the specific characters.

Valenciennes, in establishing the genus (*Comptes Rendus*, t. xli., p. 14), gave the following generic diagnosis:—"Le sclérobasse s'allongeant en baguettes droites et pectinées d'un seul côté de la tige principale."

Milne-Edwards and Haime in 1857 refer to the genus as follows:—

"Polypiéroïde s'allongeant en baguettes droites et pectinées d'un seul côté"; and also: "Polypiéroïde dont la tige et les branches sont cylindriques et ressemblent beaucoup aux Juncelles. Sclérenchyme sub-verruqueux. Couleur jaune-rougeâtre.

"*Localité*.—Mers de l'Inde."

Wright and Studer (l., p. lxvi) gave the following diagnosis:—

"The colony is branched in one plane; and so that all the simple twigs arise in an ascending order from the upper surface of the stem. The verrucae are short on two sides of the twigs. There are distinct median furrows. The spicules are warty double-clubs; those of the polyp-calyces are, according to Ridley, somewhat different from those of the coenenchyma, being longer and provided with two, often three, whorls of tubercles. The inner whorl so approach in the middle of the spicules that the median naked zone which is characteristic of the spicules of the coenenchyma is here absent."

With regard to the "Alert" specimens, Ridley says:—"The front and back of the two main (outer) branches are bare of polyps for from one-third to half their length from their origin. The verrucae are but slightly prominent on the outer branches. The colour is pale salmon."

*Localities*.—Warrior Reefs, Torres Straits, 12 fathoms.

Of the spicules he says:—"The verrucae spicules show a modification of the same type as those of the general cortex, being only more elongated than those, and bearing two or sometimes three distinct whorls of tubercles, besides a few median terminal ones on each half of the spicule; the two inner whorls almost meet in the middle, so as to obliterate the median bare zone, which is characteristic of the cortical spicules."

While working on the coast of Lower Burmah I was fortunate in obtaining a large number of this very interesting species; and these have formed the basis of a somewhat detailed study. The following table gives a few of the measurements of some of these; and notes have been added where it was considered necessary. Taken in conjunction with the various paragraphs which follow, it may serve to elucidate the more important characters of this species.

TABLE A.

Specimen.	MAIN STEM.		PRIMARY BRANCHES.				SECONDARY BRANCHES.					Notes on secondary branches	Angle at which primary branches arise	Spread, i.e. between tips of branches
	Length	Diam.	Lengths		Diameters (base)		Diameter (tip)		Number on primary		Length of longest			
			1	2	1	2	1	2	1	2				
I.	3	10.5	53	47	8	8	4	4	44	39	80	cm.	90	
II.	2.5	8.5	55	28	7	7	2	2	35	14 + 14	? broken		54	60°
III.	3	6	44	39	4.5	5.5	2	2	41	38	35		60	Primaries arise at 45°
IV.	2.5	7	32 +	37 +	6	8	?	?	24 +	35 +	?		44	60°
V.	10	5.5	39	20	5.5	5.5	2	2	35	18	?		46	50°
VI.	3	7	57	47	7	5	2	2	41	26			46	60°
VII.	7	7	48	39	8	7	2	2	52	40	40		67	45°; colour white
VIII.	4	5	38	34	4.5	4.5	1.5	1.5	23	21	31		48	45°
IX.	13 +	6	27	27	5	5	1.5	1.5	19	17	25		58	90°
X.	4	5	38	34	5	3	1.5	1.5	27	11	38		53	60°

The following notes on some of the aberrant specimens may serve to give an idea of the inherent specific character:—

II. One of the primary branches has been broken off after a distance of 28 cm.; but the branch which arises nearest that point has developed twigs on the inner side, and has so continued the general development as if primary.

VII. One of the primary branches, along with the first two secondaries which arose from it, has been broken off; but the fourth has taken its place, and continued the regular development of tertiaries just as if they were secondaries.

IX. One of the primary branches is only feebly developed, and has six short slender secondaries. The second secondary has developed tertiaries after the manner of a primary.

X. A similar mode of development to that described for II. has taken place in this specimen.

*Branching.*—The branching of this unique type is extremely characteristic. The main stem is usually very short, and gives rise to two branches dichotomously; these arise at varying angles in the different specimens. In some they lie almost horizontally (fig. 36); in others they are inclined at  $45^\circ$  (fig. 37), or even  $60^\circ$  (fig. 38), to the horizontal. In a typical specimen these primary branches give rise to secondaries on the upper inner aspect in a symmetrical manner, giving a distinct comb-like arrangement. The angle at which these arise is very characteristic. When colonies are preserved in spirits or dried, they usually contract, so that the secondary branches overlap on either side (fig. 39); but a study of these, when immediately taken from the water, shows that this does not occur when growing freely. In this condition all the secondary branches stand vertically, and arise from the primary branches at an angle complementary to that at which the primary branches arise from the main stem. Thus if the primary branches are horizontal, the secondary arise at right angles; if the primary branches arise at an angle of  $60^\circ$  from the main stem, the secondary branches come off at an angle of  $30^\circ$ . Stages between these are of course not infrequent. Fig. 3 shows the habit of a colony in the contracted condition, while figs. 36–38 show different angles of origin.

Secondary complications sometimes occur in the branching, but it is noteworthy that these tend to follow the type already described. For example, in several specimens one of the primary branches has been broken off; but the secondary branch which arose at this point has developed tertiary branches in a manner analogous to the primary branch (fig. 40). Occasionally

also the majority of the secondary branches may be only feebly developed, but one may give rise to a large number of tertiaries. Sometimes, for no apparent reason, tertiaries may arise from the secondary branches; but in all cases these arise on the *inner* side and ascend vertically, thus maintaining the specific type of branches (fig. 41).

*Main Canals.*—In every tertiary and secondary branch there are two large canals running from end to end; these correspond with the bare portions of the coenenchyma, and are consequently in the plane of branching. In dried specimens their position is usually denoted by a groove due to the collapse of the canal walls. In young colonies and in the upper part of large colonies these secondary canals unite with the canals in the primary branch, one on either side; but towards the base of older colonies they do not all unite; but the last three to ten may run parallel in the primary branches, and so pass into the main stem, where as many as twenty may be visible (figs. 42 and 43).

*Distribution of polyps.*—In no case do polyps occur on the main stem. On the primary branches they are restricted to the outer aspect, i.e., the side diametrically opposite the one from which the secondary branches arise. On the secondary branches they are disposed on the two inner surfaces—i.e., the surfaces in the plane of branching are bare (fig. 44). In the upper half of the secondary branches, however, the polyps may encroach on the bare spaces, and appear as if distributed all over the coenenchyma.

*Nature of the verrucae.*—In the younger parts of the colony the verrucae are low and dome-like; but in the older portions they seem to become smaller, and in the lowest parts may appear as pit-like depressions.

Fig. 1 shows the structure of an expanded polyp.

*Spicules.*—The spicules of this species might be said to consist almost entirely of double-clubs, or, at any rate, of double-clubs and double-spindles (fig. 45). It is possible to group these into several distinct types which *may* show an evolution-series. It is noteworthy, however, that all are practically of the same length, so that it is improbable that they are different stages in development. The following groups, with their measurements, length by breadth, in millimetres, may be distinguished:—

- (a) *Double-clubs* with hemispherical ends and a narrow bare constriction definitely marked off:  $0.057 \times 0.038$ ;  $0.053 \times 0.053$ ;  $0.053 \times 0.034$ .
- (b) *Double-clubs* with the "heads" much more open than in (a), i.e., there is a distinct whorl of warts on either side of the constriction, and the "hub" is very warty:  $0.057 \times 0.038$ ;  $0.057 \times 0.034$ ;  $0.057 \times 0.031$ .

- (c) *Double-clubs* with still more open "heads," i.e., one whorl of warts on either side of the constriction, and the "hub" with only about three warts. These approach *double-wheels*:  $0.057 \times 0.038$ ;  $0.057 \times 0.034$ ;  $0.053 \times 0.031$ .
- (d) More slender *double-clubs* with a proportionately longer constriction, and with no definite arrangement of the warts of the "heads," which might be termed divaricate:  $0.053 \times 0.031$ ;  $0.053 \times 0.027$ .
- (e) More elongated *double-clubs* which approximate to *double-spindles*. The warts are large, but have no definite arrangement:  $0.061 \times 0.023$ ;  $0.057 \times 0.023$ ;  $0.057 \times 0.021$ .
- (f) *Double-spindles* not markedly warty (in some there is hardly any constriction):  $0.057 \times 0.019$ ;  $0.057 \times 0.017$ ;  $0.057 \times 0.015$ .
- (g) The type figured as (g) is evidently a developmental form of one of the other types:  $0.046 \times 0.023$ ;  $0.046 \times 0.022$ .

A small portion, about 20 cm. long, of a primary branch of what has evidently been a large colony occurs in the Littoral Collection of the Indian Museum: twenty-seven secondary branches arise from it; all are simple except one which is dichotomously branched; the longest is 17 cm. in length.

The surface of the coenenchyma is granular; the thickness attains a maximum of 1 mm.

The polyps are disposed irregularly; on the primary branch there is one distinct bare tract, with a fairly deep groove, the other is not so evident; on the secondaries it is almost impossible to detect a bare streak.

The verrucae when expanded are slightly adpressed to the coenenchyma; when retracted they are low and dome-like. They are very small, being about 1 mm. in diameter at the base, and varying from 0.5 to 1 mm. in height.

The canal system is typical of the species.

The axis is cylindrical and yellowish; it is composed of concentric laminae, and there is a distinct white core which is more calcareous than the outer laminae. There is a slight trace of grooving on the surface. The anthocodiae and spicules agree in every detail with those described for the species.

*Locality.*—Andamans.

*Note.*—This specimen is described in the table given in the Indian Ocean Littoral Aleyonaria Report (Thomson and Simpson) as specimen M.

*Distribution* :—

Indian Ocean (Pallas).  
Seas of the Moluccas (Lamarck).  
India and China (Gray).  
Cuba (British Museum Collection of H. Christy).  
Off North-West Cape, West Australia, 3-4 fathoms (Studer).  
Torres Straits (Studer).  
Cuba (Ridley).  
Warrior Reef, Torres Straits, 12 fathoms (Ridley).  
Mergui Archipelago, Burma.  
Andamans (Ind. Mus. Litt. Coll.).

## ELONGATA GROUP.

This group is easily differentiated from the others by means of its spiculation. The spicules are characteristic and very minute.

XX.—*Scirpearia elongata* (figs. 46-48).

- Gorgonia elongata* Pallas, xxviii., p. 179.  
*Gorgonia elongata* Esper, vii., t. lv.  
*Gorgonia elongata* Lamarck, xxiv., t. ii., p. 220, 2nd ed., p. 499.  
*Gorgonia elongata* Dana, iii., p. 664.  
*Juncella elongata* Valenciennes, xlv., p. 182.  
*Juncella elongata* Valenciennes, xlvi., p. 14.  
*Gorgonia elongata* Ellis and Solander, vi., p. 96.  
*Juncella elongata* Milne-Edwards and Haime, xxvi., i., p. 187.  
*Juncella elongata* K  lliker, xxiii., p. 140.  
*Ellisella elongata* Gray, x., p. 287.  
*Ellisella elongata* Gray, xi., p. 481.  
*Ellisella elongata* Gray xii., p. 25.  
*Ellisella coccinea* Gray, x., p. 287.  
*Ellisella coccinea* Gray, xi., p. 481.  
*Ellisella coccinea* Gray, xii., p. 26.  
Nec. *Juncella elongata* Hickson, xiii., p. 85.  
Nec. *Juncella elongata* Thomson and Henderson, xl., p. 81.

This is a very old species, but one which has caused more trouble to systematists than any other in the group, owing to the fact that the spicules have hitherto never been investigated. The descriptions, based on a few superficial characters, are so vague that on these alone it is possible to identify almost any branching *Gorgonella* with this species.

It is very doubtful if the long list of synonyms given here were in all cases correctly identified; but in the absence of the specimens themselves, it is better to retain them until definite information on this point is forthcoming.

While examining the Alcyonaria in the Museum of the Royal College of Surgeons, London, I came across a beautiful specimen labelled *Gorgonia elongata* (Reg. No. 184), belonging to the Hunterian Collection, of which the following description occurred in the catalogue:—"It consists of a short, broad stem, from which seven main branches arise; these, after proceeding about 6-7 inches, give off a branch which proceeds upwards nearly parallel with the main stem, and about equal to it in thickness. The crust is of a vermilion colour; and the polyp-cells are very numerous and arranged in alternate rows, especially towards the free extremities of the branches, which are all more or less flattened. The axis is of a light yellow colour, and of a small size in comparison with the crust."

*Habitat*.—West Indies.

As this is the oldest authentic specimen bearing the specific name *elongata*, I have considered it advisable to resuscitate this old species, give it some positive content, and regard this specimen as the type. For this purpose, Dr. Burne has supplied me with a beautiful photograph of the colony and also a sketch drawn with a "camera lucida," on which fig. 46 is based. Preparations of the spicules have also been made for the first time, and fig. 48 gives the chief types which occur.

In the collection of Gorgonellids in the British Museum, there is a very delicately branched colony which Gray referred to the species *Ellisella coccinea*, established by him in 1857, with the following diagnosis:—"Coral furcately branched; branches sub-cylindrical, very long, virgate; bright scarlet." The spicules of this specimen are identical both in types and measurements with those of the specimen in the Hunterian Collection (figs. 47 and 48), and an examination of the general habit of the two colonies will at once render it obvious that they cannot be regarded as distinct. Both the specimens are from the "West Indies."

The type specimen (fig. 46), is almost 1 metre in height, and is complete. There is a large spreading basis of attachment from which a very thick stem about 12 mm. in breadth arises. The branching commences almost at the very base. One of the primary branches is 4.1 mm. in diameter; but the secondary branches, at a considerable distance from this, have a breadth of 4 mm.; about the middle of the colony the smaller elongated branches are 3.5 mm. in diameter, and at 8 cm. from the tip they are 2 mm. in diameter. There is considerable anastomosis in the lower part.

The branching is distinctly dichotomous, and the branches enclose an acute angle; this is also very marked *Ellisella coccinea*.

The coenenchyma is very thin, and in the dried state extremely brittle; it is densely spiculose.

The canal system is not easily recognized, owing to the fact that both the specimens are very old, and have been preserved in a dry condition; but it is still possible to detect two large longitudinal canals. Their position is, however, very marked externally.

The polyps are disposed throughout the whole colony in two very definite longitudinal series, separated by very wide and distinct bare tracts, which, in the lower region, are depressed and furrow-like. In the older branches there are four to six rows of polyps in each series; these are situated in what appears to be diagonal arrangement. In the younger branches and twigs the number diminishes to two, and eventually to a single row situated laterally and irregularly alternating.

The verrucae are slightly elevated, with the oral aperture directed upwards, but they are very much shrivelled, owing to desiccation.

The axis is typically Gorgonellid in structure, and is very hard, especially in the lower portions. The fact, however, that the specimens are dry renders the axis harder and more brittle.

The spicules of this species are extremely characteristic and very minute. They consist of (1) small double-clubs with closely set, almost smooth warts; (2) double-clubs with more irregular heads; (3) small, slender, elongated double-clubs; and (4) spindles. (See figs. 48 and 48A.)

The following are some of the measurements, length by breadth, in mm.:—

- (1)  $0.068 \times 0.042$ ;  $0.065 \times 0.042$ ;  $0.053 \times 0.038$ .
- (2)  $0.061 \times 0.03$ ;  $0.057 \times 0.025$ ;  $0.057 \times 0.03$ .
- (3)  $0.061 \times 0.023$ ;  $0.061 \times 0.019$ ;  $0.057 \times 0.015$ .
- (4)  $0.06 \times 0.023$ ;  $0.058 \times 0.015$ .

*Locality*—West Indies.

#### FLAGELLUM-GROUP.

This is a very distinct group, and is characterized chiefly by the nature of the spicules. These are remarkable for the great length of the constriction, the open disposition of the warts, and the almost smooth nature of the latter.

XXI.—*Scirpearia flagellum* emend. Figs. 49–60.

1863. *Juncella flagellum* Johnson, xviii, p. 505.  
 1864. " " " xix, p. 142.  
 1870. *Viminella* " Gray, xii, p. 29.  
 1881. *Scirpearia* " Studer, xxxvi, p. 558.  
 1891. " *ochracea* Studer, xxxvi, p. 559.  
 1901. " *flagellum* Studer, xxxviii, p. 53, Pl. ix., figs. 1–3; Pl. xi.,  
       figs. 10 and 11.  
 1901. " *ochracea* Studer, xxxviii, p. 53, Pl. ix., figs. 4–6.  
 1909. " *flagellum* Thomson and Russell, xliii, p. 163, Pl. 8,  
       fig. 2.

This is a very old species, and was originally referred to the genus *Juncella*. In 1870 Gray assigned it to his new genus *Viminella*; but with no apparent reason, and without giving any further specific content. He, however, gives as a synonym, *J. extans* Verrill; but as this was based on purely external characters, it is extremely doubtful whether much stress can be laid on the identity with the latter species. We have for this reason excluded it from the list of synonyms. In 1901 Studer rehabilitated the species, and gave a description of the spicules and, also, very good figures of the colonies. He referred the species to the genus *Scirpearia*. He, however, established another species—namely, *ochracea*, which cannot now be regarded as distinct from that under consideration, and which we therefore give as a synonym.

With regard to *Juncella flagellum*, Johnson, in establishing the species, says:—

"I have ventured to assign this coral to the genus *Juncella*. Valenciennes, a naturalist for whom I entertain the highest respect, considers it to be the *Scirpearia mirabilis* of Cuvier. There is, however, so much doubt as to what the coral so named by the illustrious Frenchman really is, that I hesitate to ascribe mine to that species—the more especially as it clearly falls within the definition of the genus *Juncella*<sup>1</sup> (as it appears in the "Histoire Naturelle des Corallaires" of Milne-Edwards, vol. 1, p. 186), forming a member of the section of Gorgonellaceae, which is made up of Gorgoniad corals, having a smooth bark and a sub-lithoid axis, containing so much carbonate of lime as to effervesce in muriatic acid. From *Juncella juncella* Esper and *J. vimen* Val. (species found at the Island of Bourbon) it

<sup>1</sup> The introduction of the study of spicules has, however, removed it from the genus *Juncella*, from the fact that it contains no club-shaped spicules.

would seem to be distinguished by the large size of the cup-bearing papillae; from *J. elongata*, a Mediterranean species, by its being simple, not branched."

The original description of the species is as follows :—

"Simple, elongated, slender, flexible, slightly twisted on its own axis, and tapering upwards. Bark calcareous, white, smooth, and impuncturate, enveloping a hard, grey axis, which has a somewhat polished surface, marked with straight striae. The axis is highly charged with carbonate of lime. The coral is quadrangular in section, and has on each of the two narrower sides two series of closely set papillae, having the eight-lobed orifices of polyp cells at their apices. These papillae are obpyriform or ovate; and in dried specimens they are turned upwards and adpressed to the stem. Near the base of large specimens the papillae are in three somewhat irregular rows. The other two sides of the stem are free from papillae; but there is a slightly elevated line along the middle. The base spreads out to a moderate extent upon the object to which it is attached. The spicula of which the bark is composed are tuberculated staves, two or three times as long as broad, the tubercles having a tendency to collect at the extremities.

"The longest example of this coral which I have seen measured about 7 feet in length; and it was without its basal portion. The greatest thickness was three-eighths of an inch; the largest papillae were the tenth of an inch in length, and about the same across. In another example, 5 feet in length, the base spread out to the size of a shilling; and the papillae commenced about 3 inches above this basal expansion. The smallest specimen that has occurred was 31 inches long; this is in the British Museum. In the collection of that establishment there is a large stone, with numerous specimens of this coral<sup>1</sup> upon it, alongside examples of *Caligorgia verticillaris* Gray (*Primnoa verticillaris* Milne-Edwards). These were brought from St. Michael's, one of the Azores, and presented to the Museum by Mr. McAndrew."

Studer (xxxviii.) adds the following note with regard to the "Monaco" specimens :—

The colonies are long and flexible, and attain a length of 650 mm. The polyps are club-shaped, slightly inturned towards the axis; they are arranged on two sides of the stem; in the lower part in several rows; but towards the tip in a single row, alternating on the two sides. The spicules are spindles and double-clubs. Their dimensions are  $0.067 \times 0.015$  mm.;  $0.061 \times 0.0154$ ;  $0.056 \times 0.015$ ;  $0.067 \times 0.025$ .

The colour varies from whitish yellow to red.

<sup>1</sup> It is, of course, doubtful whether these are really *J. elongata*, as it would be impossible to decide their specific or even generic position by a superficial examination.

*Locality*.—To the east of Graçiosa, Azores, 454 metres.

To the east of Pico, Azores, 318 metres.

With reference to *S. ochracea* Studer (xxxviii.) makes the following observations:—

This species is more delicate than *S. flagellum*. The axis is calcareous; white; rigid near the base, flexible near the tip. The polyps occur on two sides of the stem; towards the base in two irregular rows, but merging into only one row on each side. They have the shape of cylindrical warts or truncated cones, and stand almost perpendicularly to the coenenchyma. They are 2 mm. in height, and about 2 mm. in diameter at the base. The spicules are very like those of *S. flagellum*; they consist of double-clubs, with large warts and spines at the two ends: sometimes of a yellowish ochre, sometimes of a white colour. They are slightly larger than those of *S. flagellum*.

The colour of the colony is yellowish brown to orange.

Taking into consideration what has already been seen with regard to variation in the group, we see no reason for separating this off as a distinct species.

*Locality*.—To the east of Pico, Azores, 318 metres.

We have examined a beautiful, whip-like colony, 37 cm. in length, from Naples,<sup>1</sup> which we refer to this species. The diameter near the base is 2 mm.; but near the tip it is only 1 mm. It gradually tapers upwards, but the terminal 25 cm. are almost uniform in thickness throughout.

The coenenchyma is very thin and finely granular; the surface is marked by longitudinal ridges and furrows, which are the outward expression of the internal canals; two of these are much deeper than the others. The general colour of the colony is reddish orange, but the tips of the verrucae are distinctly more reddish.

The lower 2·5 cm. of the stem are devoid of polyps; this is followed by two opposite longitudinal bare tracts which persist to the tip of the colony. On the other two sides the polyps are disposed in a single row in each series. This gives the colony a very markedly bilateral appearance. The verrucae are cylindrical, tall, and narrow. They average 2 mm. in height and 1 mm. in diameter. They stand sometimes in opposite pairs; but the more common arrangement is alternate. The polyps on the same side are separated by distances of about 3·5 mm. The verrucae are longitudinally striated; and the summit has a very definite eight-rayed structure. They stand almost

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<sup>1</sup> This specimen was given to me for identification by Professor J. Arthur Thomson, who suggested that it might be incorporated in this memoir.

perpendicularly in many cases; but more frequently they are slightly turned towards the stem (fig. 49). A very noteworthy feature in this connexion is to be observed. The colony has been broken and preserved in two portions. In the longer upper part the polyps are nearly all directed towards the tip; while in the lower part they are almost all turned downwards. Taking these points into consideration, it may be inferred that the verrucae have power of rotation through  $180^\circ$  both longitudinally and vertically, or, in other words, the anthocodiae may take up any position on the surface of a hemisphere whose radius is the length of a polyp.

The canal system is well developed, but there are very few canals, owing to the small number of polyps which occur on the colony. The two main canals are very large; and their position is indicated on the surface of the coenenchyma by two very delicate depressions on the axis; also by two grooves larger than the others.

The axis is hard and densely calcareous; it is yellow in colour; and the surface is marked by longitudinal ridges and furrows.

Attached to the colony is a young bivalve (probably *Pteria macroptera*).

The spicules of this specimen consist of the following types (fig. 50):—

- (1) Double-clubs with a long, narrow constriction, and with almost hemispherical ends. The warts are irregularly disposed, are few in number, and are almost smooth:  $0.07 \times 0.03$ ;  $0.065 \times 0.03$ ;  $0.065 \times 0.023$ .
- (2) More elongated double-clubs with the same characteristics, and with blunt ends.

A noteworthy feature about this specimen is the fact that there are very few double-spindles or types with conical ends.

*Locality.*—Naples.

We have also referred to this species a specimen in the Cape Collection. The spiculation is typical; and the only difference is the very close disposition of the verrucae. We have shown, however, that this is a character in which the species shows great variability. It is a very characteristic colony, growing on a piece of branching coral (like *Lophohelia*) (fig. 51). It is 9 cm. in length, and bears one branch (which has been broken) at a distance of 2 cm. from the base. The coenenchyma is thin and coarsely granular. The general colour of the colony is creamy-white.

The lower 2.5 cm. of the main stem and also the part of the branch which is present (1.5 cm.) are devoid of polyps. On the remainder of the main stem the verrucae are disposed on two sides, and alternate almost regularly. They have the form of flattened domes, and give the sides of the colony a

very undulating appearance (fig. 52). Their bases meet in the middle line. The tips of the verrucae have a very definite eight-rayed structure. Fig. 53 was made from a longitudinal section through the colony to show the attachment of the strong retractor muscles of the anthocodiae.

The canal-system is typical, but the inner portion of the coenenchyma, that is to say, the portion between the two longitudinal series of canals, is very minute.

The axis is pale yellow in colour, and very flexible; the surface is marked by indistinct longitudinal striae. The spicules (fig. 54) of this specimen are typical of the species, but are on the whole larger and broader.

*Locality.*—Buffalo River, East London, N., 15 miles, 310 fathoms. Bottom, coral and mud.

In the Cape Collection there are also a number of small young colonies, which are extremely interesting, and which are undoubtedly young forms of this species. The longest of these is 7.5 mm. and the smallest 3.5 cm. in length. They have all the same general appearance, and maintain the relative proportions throughout, so that a short description of one colony will give the essential characters (fig. 55). All are attached to pieces of rock, coral, or shell.

The stem is about 1 mm. in diameter near the base, and only very slightly less at the tip. The coenenchyma is very thin, and finely granular; the general colour of the colonies is a bright orange-yellow.

The polyps are disposed in two longitudinal series; and although the two median bare tracts are not well pronounced, the colony has a markedly bilateral appearance. They occur in a single row in each series; but the interposition of young forms sometimes masks this distribution. They stand sub-opposite or sometimes alternately; but the young polyps tend to break this otherwise regular structure (fig. 56).

The verrucae are elongated and cylindrical; they are turned towards the stem, and are directed upwards; their surface is marked by longitudinal ridges and depressions; the apex when partially closed has a distinct eight-rayed structure; in many cases the infolded tentacles may be seen projecting around the oval opening.

The canal system is well developed; the canals are distinct but few in number; the two main canals are large. The axis is cylindrical, hard, and very calcareous; the surface is marked by very indistinct longitudinal striae.

The spicules (fig. 57) are characterized by the small number and large size of the almost smooth warts and by the very marked constriction in the

double-clubs. The following are the chief types, with measurements, length by breadth, in millimetres :—

- (1) Double-clubs with a very long constriction and with almost hemispherical ends. The warts are almost smooth; they are openly disposed and arranged almost in whorls:  $0.068 \times 0.034$ ;  $0.061 \times 0.03$ ;  $0.057 \times 0.027$ .
- (2) Elongated double-clubs passing to double-spindles. There is a very distinct constriction; and the ends are markedly conical. The warts are not closely set, and are almost smooth:  $0.114 \times 0.023$ ;  $0.103 \times 0.023$ ;  $0.095 \times 0.027$ ;  $0.095 \times 0.023$ .

Irregular forms, crosses, and scales from the tentacles also occur.

*Locality*.—O'Neil Peak, N.W.,  $\frac{1}{4}$  W.  $9\frac{1}{2}$  miles; 90 fathoms. Bottom, broken shell.

To show the varied appearance of the verrucae, we have included here three figures of specimens of *Scirpearia flagellum* in the Monaco Museum. (See figs. 58, 59, and 60.)

## XXII. *Scirpearia thomsoni*, n. sp., figs. 61-63.

*Juncella elongata* Thomson and Henderson, xl, p. 81, Pl. I., fig. 10; Pl. IX., fig. 17.

We have no hesitation in establishing this new species for a specimen which was originally referred to the species *Juncella elongata* by Thomson and Henderson, who were compelled to base their diagnosis on the very inadequate description of this species which was available at the time of publication of the Indian Ocean Deep Sea Aleyonaria Report. At that time the spicules of *Scirpearia elongata* (*Juncella elongata*) were unknown; but an investigation of the spicules of an old specimen in the Museum of the Royal College of Surgeons, and the consequent resuscitation of that old but imperfectly known species has caused the necessity of removing the present specimen.

The colony shows several very characteristic features: for example, (1) the nature of the branching, (2) the marked rigidity of the colony, (3) the nature of the verrucae; but most of all the distinctive character of the spicules, which mark it off as a very definite and new species.

The specimen is 22 cm. in height, and is branched approximately in one plane. The branching is almost dichotomous; and the silhouette of the axis (fig. 61) gives the essential features. On the whole, the colony is very rigid, owing to the very densely calcareous nature of the axis. The coenenchyma is moderately thin, but densely spiculose; the general colour of the colony is salmon-pink.

"The axis is calcareous, rigid, and brittle; it is slightly oval in section; but in the younger portions it becomes quite cylindrical, and tapers till it is thread-like. It shows a very white core surrounded by a brownish cortex."

The polyps are disposed in two longitudinal series on opposite faces, each of which consists of from two to four irregularly alternating rows. The verrucae are low and truncate; when retracted there is a deep depression in the centre which is directed slightly upwards. This gives a very characteristic appearance (fig. 62). They are about 0.4 mm. in height and 1.5 mm. in diameter at the base.

The spicules are extremely characteristic, and quite unlike those of any other species (fig. 63). They consist of the following types, with measurements, length by breadth, in mm.

- (a) Double-clubs with almost hemispherical heads, and with a relatively long constriction. On either side of the constriction the large warts are arranged in a whorl, while beyond this there is a very warty hub which gives the whole head a very irregular outline:  $0.08 \times 0.04$ ;  $0.07 \times 0.035$ .
- (b) Smaller double-clubs in which the whorl is not so pronounced:  $0.07 \times 0.46$ ;  $0.07 \times 0.042$ .
- (c) A peculiar type, which approximate to capstans with terminal warty projections:  $0.08 \times 0.04$ ;  $0.07 \times 0.021$ .
- (d) Elongated double-clubs with a long, narrow constriction, with the inner warts arranged approximately in a whorl, and with more or less elongated and irregularly warted hubs:  $0.114 \times 0.053$ ;  $0.114 \times 0.046$ ;  $0.095 \times 0.05$ .
- (e) Double-spindles (some of these approach spindles). The ends are almost conical, and are variously covered with very irregular warts which give the whole a very ragged outline:  $0.125 \times 0.038$ ,  $0.11 \times 0.03$ ;  $0.1 \times 0.027$ .

*Locality*.—Bay of Bengal, 88 fathoms.

### XXIII. *Scirpearia alba* (Thomson and Henderson), figs. 64 and 65.

*Scirparella alba* Thomson and Henderson, xl., p. 82, Pl. ix., fig. 15.

This species was established for three long, incomplete specimens, of a white colour, 28, 411, and 408 mm. in length, with a corresponding diameter at the lower end of 1.75, 2.3, and 1.75 mm.

Two of the colonies are unbranched; but the largest branches at a distance of 251 mm. from the lower end.

The axis is cylindrical, hard, brittle, and very 'calcareous, but becomes

very flexible and filiform near the tip. It is marked by a number of grooves which run up for a short distance, and also by a number of small protuberances.

The stem is oval in section, with a groove on the two flattened surfaces faintly marked in two of the specimens.

The verrucae occur *in a single row on each side of the stem*, those of one row alternating with those of the other. They are low and truncated (0.45 mm. in height), laterally compressed, with spreading basis (fig. 64).

The diameter is 1.4 mm. at the base and 0.65 mm. at the apex.

The coenenchyma is moderately thick.

The spicules of this species (fig. 65) are extremely characteristic. They consist essentially of double-clubs, which are almost as broad as long, and have a very short but extremely thick median constriction.

Their ends are almost hemispherical, and are covered with abundant rugose warts. There are also a few elongated narrow double-clubs, with more openly-warted heads, and with a longer constriction. Some of these approximate to spindles. Small, apparently developmental, forms and a few crosses also occur.<sup>1</sup>

The following are typical measurements of the chief types, length by breadth, in mm.:—

(a) Short thick double-clubs:  $0.15 \times 0.17$ ;  $0.15 \times 0.095$ ;  $0.13 \times 0.11$ ;  $0.13 \times 0.095$ .

(b) Slender double-clubs:  $0.15 \times 0.02$ ;  $0.13 \times 0.08$ ;  $0.09 \times 0.03$ .

(c) Irregular or developmental forms:  $0.057 \times 0.02$ .

*Locality.*—Bay of Bengal, 88 fathoms.

#### *Specific Diagnosis.*

Colony simple or slightly branched, long and filiform; axis cylindrical, calcareous, and grooved; coenenchyma moderately thick; *verrucae in a single row on each side of the stem*; spicules consist essentially of short, thick double-clubs almost as long as broad and with a very narrow constriction; the ends are almost hemispherical, and are covered with densely rugose warts.

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<sup>1</sup> The large spindles described from the type specimen of the species are undoubtedly extrinsic.

XXIV. *Scirpearia aurantiaca* (Thomson and Henderson), figs. 66-68.

*Scirpearella aurantiaca*, Thomson and Henderson, xxxix., p. 311, Pl. iv.,  
fig. 7, Pl. v., fig. 15.

*Scirpearella* sp., Thomson and Henderson, xxxix., p. 312.

*Scirpearella divisa*, Thomson and Henderson, xxxix., p. 312, Pl. vi.,  
fig. 8.

*Scirpearella aurantiaca*, Thomson and Russell, xliii., p. 163, Pl. viii.,  
figs. 4, 6, and 9.

This species was established by Thomson and Henderson for several portions of colonies from Ceylon.

The colony is slightly branched. The axis is cylindrical in shape, very calcareous, and marked by two or three slight winding grooves in the lower portions. The general colour of the branches is yellowish-white.

The verrucae occur on all sides of the branches. They are conical in shape, truncated at the tip, 2 mm. in maximum height, and 1.5 mm. in basal diameter. In colour they resemble the stem in the lower part; but the tip is orange-yellow, thus standing out against the general colour of the branches. The edges of the oral end curve inwards, and all stages, from an opening with an eight-lobed margin to a simple pore-like opening, and finally to a completely closed tip, may be seen. The polyps are all completely withdrawn into the coenenchyma.

The coenenchyma is granular in texture and only of medium thickness. It is practically composed of spindles and double-clubs.

The spicules are small in size, and measure, length by breadth, in millimetres:—

(1) Spindles:  $0.06 \times 0.03$ ;  $0.08 \times 0.02$ ;  $0.085 \times 0.03$ .

(2) Double-clubs:  $0.055 \times 0.03$ ;  $0.07 \times 0.04$ ;  $0.06 \times 0.04$ .

*Locality*.—Deep water outside pearl-banks, Gulf of Manaar.

*Scirpearella* sp., Thomson and Henderson.

We would also refer the specimen described in *op. cit.*, p. 312, to this species. It consisted of a damaged colony, broken in four pieces, attaining a total length of 48 cm. The base is present, but the tip of the colony has been lost. The main stem, after a distance of 4 cm., gives rise to a branch which has been broken off at its point of origin; a second branch arises after another 12 cm.; it is 11 cm. in length. The diameter of the main stem is 2.5 mm.; about the middle of the colony it is 1.5 mm.

The coenenchyma is finely granular, and is about 0.5 mm. in thickness throughout the entire length.

The general colour of the colony is brick-red; but the anthocodiae are white.

The base of the colony and the main stem for a short distance are devoid of verrucae, but in the polyp-bearing region they appear to occur all round the stem in rows, and so simulate a spiral arrangement. Closer examination, however, reveals two distinct longitudinal sinuous bare tracts. There are about four irregular rows in each of the polyp-bearing regions in the older parts; but in the branch, which is present, there are only two rows; while near the tip there is only one. The verrucae are small and comparatively distant. In the older part of the stem they are cylindrical, stand perpendicularly, and are about 1 mm. in height and 0.5 mm. in diameter; but in the branch they are more retracted, and almost dome-like. When partially retracted the apex is flattened, and has a distinct eight-rayed structure.

The canal system is typical; the two main canals are not much larger than the others, but are quite distinct. The axis is cylindrical, and is composed of concentric laminae; it is densely calcareous, hard yet flexible. The surface is deeply grooved, especially in the lower part. This is due to the large size of the canals of the inner longitudinal series.

*Locality*.—Ceylon Sea.

*Scirpearrella divisa*.—We have examined the spicules of this species, and can find no reason for separating it from *S. aurantiaca*. The type-specimen consisted of a fragment of a reddish-orange colony with four branches, 7 cm. in height and about 2 mm. in diameter. The verrucae are very low and gently rounded; towards the end of the highest branch, where they are closely crowded and very distinct, the arrangement appears to be in four rows with a suggestion of a spiral; in the older parts the verrucae are very inconspicuous, not close together, and somewhat irregularly disposed.

The coenenchyma is finely granular, almost smooth to the naked eye. The axis is very calcareous, light yellow in colour, with ten shallow grooves on the part examined. It is about 1.4 mm. in diameter out of a total branch diameter of 2 mm.

The spicules of this species are very characteristic. They consist of:—

- (a) Double-clubs with hemispherical heads in which the warts are arranged concentrically; the constriction is very short:  $0.0684 \times 0.049$ ;  $0.065 \times 0.038$ ;  $0.053 \times 0.03$ .
- (b) Double-clubs, slender with elongated ends, tending to double-spindles:  $0.084 \times 0.019$ ;  $0.076 \times 0.029$ ;  $0.076 \times 0.023$ .
- (c) Spindles—warty:  $0.095 \times 0.027$ ;  $0.095 \times 0.02$ ;  $0.087 \times 0.015$ .

In addition to these there are often forms which are intermediate between types (*a*) and (*b*); but these cannot be regarded as constituting a distinct type.

As we have already pointed out, the branching, as shown in this specimen, is not of a character of sufficient value for specific determination. We would therefore suggest merging it into the older species *S. aurantiaca*.

*Locality*.—Ceylon Sea.

In the Littoral Collection of the Indian Museum, Calcutta, there is a very long, simple, flagelliform colony which has unfortunately been broken into five pieces. The attachment is broken off, but very near the base, as is evident from the absence of verrucae at the present basal portion. The total length of the colony is over 112 cm. The diameter near the base (without verrucae) is 3 mm.; about midway it is 2 mm., while near the tip it is 1 mm.; so that the tapering is very slight.

The coenenchyma is very smooth, and is about 0.5 mm. in thickness throughout the entire length of the colony.

The general colour is brick-red; but the anthocodiae are white. Near the base of the colony there are no verrucae; but after a short distance they appear as if distributed all over the coenenchyma, and so simulate a spiral arrangement; a distinct trace of two bare longitudinal spaces is, however, clearly discernible; these tend to disappear towards the tip of the colony, owing to its extreme slenderness and the interlocking of the verrucae. There are five rows near the base in each polyp-bearing tract; but these gradually diminish to two near the tip. The verrucae are small and relatively distant. Near the base they have the form of short cylinders (fig. 66); but are often flattened, owing to the collapse of the thin walls; they are about 1.25 mm. in height, and 0.75 mm. in diameter, and stand almost perpendicularly. Towards the tip, however, they are smaller, more retracted, and appear as small domes directed slightly upwards (fig. 67).

The two main canals, corresponding to the two bare tracts, are clearly visible in a cross-section. The other canals of the inner series are relatively large.

The axis is cylindrical, densely calcareous, and very brittle. It tapers in a more marked degree than the colony itself. The colour of the lower part is brown, but the core is white. There are deep longitudinal depressions on the surface. The laminae are very thick, and may be seen with the naked eye, in spite of the small diameter of the axis.

The spicules (fig. 68) are quite typical of the species.

*Locality*.—Laccadives, 30–50 fms.

XXV.—*Scirpearia furcata*. Figs. 69-91.

<i>Scirpearia furcata</i>	Hickson, xv., p. 822; figs. 8 and 9.
<i>Scirpearia furcata</i>	var. (?) Hickson xv., p. 822.
<i>Scirpearella indica</i>	Hickson, xv., p. 822; fig. 10.
<i>Scirpearia</i> sp. (?)	Thomson and Henderson, xxxix., p. 313, Pl. iv. fig. 1; Pl. v., fig. 16.
<i>Scirpearella</i> sp. B.	Thomson and Henderson, xxxix., p. 312.
<i>Juncella elongata</i>	(Val.) Hickson, x., p. 821.
<i>Scirpearella aurantiaca</i>	Th. & Russell, p. 163.

Perhaps no species in the whole family shows so great variability or has given so much trouble as the one now under consideration. Hickson formed two new species on fragments from the Maldives, and referred one to *Scirpearia*, the other to *Scirpearella*. At the same time he hesitatingly referred some fragments to the species *Juncella elongata*. Thomson and Henderson, in the Ceylon Alcyonaria Report, refrained from naming some fragments which did not seem to agree with any of the formerly described species. They referred one to the genus *Scirpearia* as *Scirpearia* sp. (?), the other to *Scirpearella* as *Scirpearella* sp. B., and in so doing give the following note:—

“Our impression is that the elongated forms of *Scirpearella*, *Juncella*, and the like, so monotonous in general appearance, so perplexingly different when one gets beneath the surface, are subject to great variability.”

Before proceeding to differentiate the reasons upon which I have merged all these species under the earliest name it might be well to give a short description of the different specimens. Professor Hickson has very kindly sent me small portions of his *Scirpearella indica* and *Juncella elongata*, as well as the type specimen of *Scirpearia furcata* figured in his report. Professor Thomson has also placed pieces of the Ceylon specimens at my disposal. This has been of immense service to me, as only by means of a critical examination of these and other specimens to be described later, could a thorough specific determination be arrived at.

*Scirpearia* sp. (?) Thomson and Henderson.

A beautiful colony, 41 cm. in length. The base has been broken off, but probably not far from the present base. The main stem, after a distance of 4 cm., bifurcates, and gives origin to two long, whip-like branches; these are almost equal in length. The diameter of the main stem is 2.5 mm., that of the branches at their origin 2 mm., and near the tip 1.5 mm. There is thus only a very gradual tapering.

The coenenchyma has a very arenaceous surface, and is moderately thin.

The general colour of the colony is reddish orange; but the verrucae are distinctly red.

The polyps are disposed in two longitudinal series, each consisting of two or three transverse rows, and separated by two distinct bare tracts (fig. 69). There is no flattening of the branches, nor is there any sign of a longitudinal depression. The verrucae are low and slightly dome-like.

The axis is slender, tapering only slightly, and is deeply grooved. It is composed of concentric laminae, and is densely calcareous; the diameter at the base is 1.5 mm., but it is hair-like at the tip.

*Localities*.—Ceylon Seas.

*Scirpearia furcata* Hickson.

This species was established for two fragments from the Maldives. The larger was 90 mm. long. Both exhibited an orange-red-coloured coenenchyma, with dark red dome-shaped verrucae, closely crowded, but separated into two groups by broad, spirally directed, bare tracts. The more delicate specimen had a single branch which was bifurcated at its extremity. (See xv., fig. 8.)

*Localities*.—S. Nilandu, 25 fathoms; N., Male, 20 fathoms.

*Scirpearia furcata* var. (?) Hickson.

A specimen 200 mm. long, slightly branched, and differing from the type. It is more delicate in build, has less prominent verrucae, and the colour is not so much a pure red, but is tinged with orange.

*Locality*.—N. Nilandu (Maldives), 24 fathoms.

Superficially, these different specimens are hardly distinguishable. The forked specimen of *S. furcata* and the type specimen of *S. sp* (?) are identical in colour and in the distribution and nature of the verrucae; but the branches in the former are short; while in the latter they are long and whip-like. The other specimens of *S. furcata* and the type specimen of *S. furcata* var. (?) seem, however, to form intermediate links. Let us now consider the specimens referred to *Scirpearella*.

*Scirpearella indica* Hickson.

This species was established by Hickson for several specimens from the Maldives with the following characteristics:—

All are unbranched. The diameter of the specimens varies very little, and is in all about 3.5 to 4 mm.; the apex is blunt. The verrucae vary considerably. In one specimen they are pointed and about 1 mm. in height; at the base of the other, they are broader and less prominent. In places they have an appearance like "a shallow ledge that reminds one of the edible nests of the swallow (*Collocalia*)," similar to that described by Wright and Studer for *S. profunda*. The verrucae are arranged in six or seven slightly spiral rows.

The colour varies in the different specimens. In one the coenenchyma is white, but the tips of the verrucae are red. In another the verrucae are white throughout; but there are streaks of pink along the coenenchyma running irregularly and uniting at the base to give the coenenchyma a general pale red colour. Other specimens are entirely white.

*Locality.*—S. Nilandu (Maldives), west passage of Atoll, 30 fathoms.

*Scirpearrella* sp. B. Thomson and Henderson.

A somewhat damaged colony, which has unfortunately been broken in five pieces. The base is complete, but a short piece at the tip has been lost. The total height is 28 cm.; the diameter near the base is 3.5 mm.; but near the present tip it is 1.5 mm. At a distance of 20 cm. from the base there is a distinct angular bend; it is difficult to say whether this is the origin of a branch or a growth consequent on fracture.

The coenenchyma is extremely thin and finely arenaceous. The general colour is pale-pink or salmon-pink; but the verrucae are white, and streaks of the same colour permeate the coenenchyma.

The polyps are apparently distributed all over the colony; but close examination reveals two indistinct, sinuous longitudinal bare tracts. The verrucae are low domes, and scarcely project beyond the coenenchyma (fig. 70).

Owing to the extreme thinness of the coenenchyma, the canal system is very ill-defined.

The axis is very calcareous, hard, and, in the younger parts, brittle. It is composed of very thick concentric laminae; the surface is faintly and irregularly marked by grooves.

*Locality.*—Ceylon Seas.

As was the case with the two species already discussed, the two now described are identical on superficial examination. Let us now proceed to investigate in what respects the two groups differ.

*furcata*-group.

The verrucae are separated into two longitudinal series by two very distinct bare tracts.

There are two or three longitudinal rows in each series.

The verrucae are low and dome-like.

*indica*-group.

The verrucae are separated into two longitudinal series by indistinct bare tracts which may even disappear near the base.

The verrucae appear as if distributed in five to seven slightly spiral rows.

The verrucae may be (1) long and pointed, (2) projecting ledges, (3) low and dome-like, (4), almost level with the coenenchyma.

Thus we see that, although superficially they may present very different appearances, when we investigate the various characters nothing of specific moment can be found to obtain. The question of "five to seven slightly spiral rows" resolves itself into two series of two to four rows in which the bare tracts are hardly distinguishable.

*Juncella elongata* (Val.) Hickson, xv., p. 821.

Hickson referred some fragments to this species, but expressed doubt as to the identification. He gave the following notes:—One specimen (in three pieces) was 315 mm. in length. The total diameter was 3·5 mm., and the axis 2 mm. in the middle region. Nearer the base the coenenchyma is relatively thin or very thin, and nearer the apex much thicker. The colour of the coenenchyma is pale pink and the verrucae are throughout shallow domes, white in colour. The verrucae are separated by distinct bare tracts into two longitudinal series. In the portion I examined there were six to seven rows in each series. Other specimens were pale red and orange-red in colour. In the latter, which was 230 mm. in length, the verrucae were scattered and prominent towards the distal end, but there is an almost smooth coenenchyma near the base (fig. 71).

The spicules are double-clubs, warted spindles, and a few more elongated spindles, with fewer tubercles arranged in regular rows. The warted spindles and double-clubs vary in length from 0·08 to 0·085 mm. Some of the pointed spindles are 0·1 mm. in length. There is evidently a good deal of variation in the shape of the spindles (fig. 72).

The colour, the prominence of the verrucae, and the definiteness of pronounced tracts free from verrucae, are also characters in which the species shows much variation.

*Locality*.—S. Nilandu, 25 to 30 fathoms (Maldives) Hulule, Male Atoll, 25 to 30 fathoms (Maldives).

*Note*.—In one specimen Hickson says clubs similar to those in *J. juncea* occur; but this probably belonged to that species.

In the Littoral Alcyonaria Collection of the Indian Museum there is a portion, 35 cm. in length, of what has evidently been a long flagelliform colony; both the basal and terminal parts are wanting.

The coenenchyma is granular and moderately thick. The diameter is almost constant throughout the part under examination; it is about 4 mm., while that of the axis is 2 mm. The general colour of the colony is orange-red, but the anthocodiae are white.

The polyps are disposed in two longitudinal series separated by two narrow

bare strips which become more indistinct, but still visible, towards the tip (fig. 73). These are spirally twisted; but this is, no doubt, due to a general torsion of the colony. In each series the polyps appear in rows diverging from the bare tracts; this gives a very marked spiral arrangement, but this is also due to torsion. Transversely four or five is a common number in each series. The verrucae are sub-cylindrical and closely adpressed to the stem; the outer insertion is lower than the inner. They are about 1.5 mm. in height and 0.75 mm. in diameter at the base. When retracted they are sub-conical, and have eight converging lips (fig. 74).

The canal system is very definite and typical; the two main longitudinal canals are extremely large.

The axis is yellow in colour, and markedly calcareous; the surface is apparently smooth; it tapers only slightly in the portion preserved.

*Locality*.—Off Table Island, Cocos Group, Andamans, 15-35 fathoms.

When we take into consideration the fact that the great majority of these forms are fragmentary, and also the slight basis on which the genera *Juncella*, *Scirpearia*, and *Scirpearella* were formerly differentiated, there is small cause for wonder that the various specimens were referred to one or other of these genera on account of differences which we hope to show are not specific, but only different manifestations assumed by extremely plastic organisms.

We have made a very exhaustive study of the spicules in all the forms of which descriptions have been given; and although these show certain deviations, nevertheless they may be grouped into a number of more or less definite types.

Fig. 75 gives a very good representation of the different types and deviations therefrom in the case of the spicules in the Indian Museum specimen. Fig. 72 of the spicules of Hickson's *Juncella elongata* has also been added, and a comparison of these two groups should at once indicate the affinities of these two apparently different forms. A similar comparison might be made with regard to the others with a like result.

If, then, the character of spiculation can be regarded as specific, we should be compelled to unite all these extremely divergent forms into one very variable species. This procedure may, at first sight, seem rather drastic, as, it may be argued, the different variations occurred not in each specimen but in different specimens.

They distinctly show a range of variation which cannot be easily comprehended within an individual colony.

We are, however, fortunately in the possession of a large colony which has the same characteristic spiculation, and which does actually show a range

of variation as great as, if not greater than, that recorded for the individual portions hitherto described.

We therefore propose to give a fairly exhaustive account of this colony, and regard it as the type of the species in its emended form.

A beautiful colony of an orange-red colour 52 cm. in height and about 16 cm. in breadth. It is largely branched, approximately in one plane, and in a manner similar to that in *Juncella gemmacca*. It is complete to the very base; but some of the branches have been broken off. These are nearly all preserved, however; and it is possible to piece them together so as to get an idea of the nature of the colony as a whole when living (fig. 76).

The main stem has a diameter of 4.5 mm. at the base and 3.5 mm. at a height of 100 mm. where it has been broken off.

The first branch arises at a distance of 18 mm. from the base; it is 3 mm. in diameter at its point of origin, and tapers gradually to a point; it is 145 mm. in length. The second arises after another 33 mm., and attains a length of 445 mm.; it is 4 mm. in diameter at its origin, and gives rise to a secondary branch 375 mm. long after a distance of 82 mm.; the diameter of the latter is 3 mm. at its point of origin. A third primary branch comes off at a distance of 95 mm. from the base, and is 3 mm. in diameter near its origin; it is 430 mm. in length, and tapers gradually to a conical point.

The coenenchyma is thin and finely granular; it is of a pale yellow colour, but the verrucae are red. Near the base long streaks of red extend longitudinally from the verrucae and interlock, giving a peculiar tessellated pattern (cf. the type specimen of *Scirpearella* sp. B.). This feature may be seen in other parts of the colony.

The polyps are disposed on the branches in two longitudinal series, separated by two distinct bare tracts, which may be more irregular or even altogether absent.

Near the base the verrucae are only slightly elevated, and in many cases hardly project beyond the coenenchyma (fig. 77).

Near the origin of the second primary branch there are 3-5 longitudinal rows in each series; the verrucae are low and dome-like, or in some cases like bluntly truncate cones, having an eight-rayed structure at the summit (fig. 78).

About midway on the third primary branch there are 4-5 longitudinal rows in each series; the verrucae are sub-cylindrical and closely adpressed to the stem (fig. 79).

Towards the tips of the branches the number of rows of polyps in each series diminishes to two and eventually to one; the verrucae are sub-cylindrical or in some cases dome-like (fig. 80).

Thus we see that this specimen exhibits all the variation phases which are represented in the various specimens previously discussed.

The canal system is typical; the two large main canals corresponding to the two bare tracts are very pronounced.

The axis is cylindrical, calcareous, and made up of concentric laminae. It tapers gradually from the base upwards, and is fairly flexible. The coenenchyma is thus of an almost uniform thickness throughout. The surface of the axis is marked by longitudinal striae, the number of which varies in the different parts of the colony. The following are the chief types of spicules (fig. 81), with their measurements, length by breadth, in mm :—

- (a) Small double-clubs with a narrow constriction, and with openly warted ends:  $0.076 \times 0.038$ ;  $0.068 \times 0.046$ ;  $0.068 \times 0.034$ .
- (b) Smaller double-clubs with comparatively few warts on the ends:  $0.065 \times 0.034$ ;  $0.061 \times 0.03$ ;  $0.057 \times 0.038$ .
- (c) Smaller double-clubs with the ends more densely covered with smaller warts:  $0.046 \times 0.023$ ;  $0.042 \times 0.019$ ;  $0.038 \times 0.015$ .
- (d) Elongated double-clubs with openly warted ends:  $0.08 \times 0.023$ ;  $0.068 \times 0.031$ .
- (e) Elongated double-clubs with closely warted ends:  $0.072 \times 0.03$ ;  $0.068 \times 0.027$ ;  $0.065 \times 0.023$ .
- (f) Narrower double-clubs, simulating spindles:  $0.076 \times 0.019$ ;  $0.072 \times 0.023$ ;  $0.065 \times 0.019$ .

*Locality*.—Providence Island, 29 fathoms.

In the Cape Collection there is a large number of colonies which are extremely diverse in external appearance, but all of which have essentially the same spiculation. It is absolutely impossible to differentiate these from *S. furcata*, so that I have decided to include them in this species and give a few notes on each specimen, with special reference to the variations.

In addition to the more mature colonies, there are a few undoubtedly young forms, the largest of which is only 50 cm., and the smallest 8.5 cm. in length. All are of a creamy-white colour, and form a striking annectant series, showing the various "types" of verrucae which are undoubtedly only different stages in retraction (fig. 82).

*Locality*.—Hood Point, N.,  $5\frac{1}{2}$  miles, 42 fathoms. Bottom: sand and shells.

We shall commence with those forms in which the verrucae are very small, and gradually pass to those in which they are more expanded, and show that a series exists connecting the most extreme types.

A beautiful, simple colony of a pale orange colour. It is 17 cm. in length. The base is broken off and the tip is dome-like.

The coenenchyma is moderately thick, and is finely granular. The polyps are distributed over the whole of the coenenchyma; in some parts they appear as if in spirals, but they are in reality in longitudinal rows, the members of which irregularly alternate. Four of these rows may be seen from one aspect. The verrucae are extremely small, and are sunk into pits in the coenenchyma, so as to be almost level with it (fig. 83). The members of one longitudinal series are separated by distances about three to four times the length of the verrucae. The verrucae themselves are somewhat cylindrical, and have a distinctly eight-rayed summit. There is not the slightest trace of a bare tract.

The canal system is, however, typical. The two large main canals are quite prominent in a cross-section. This reminds one of the type of *Juncella juncea* with non-projecting verrucae.

The axis is lamellar, densely calcareous, and very hard; the surface is indefinitely marked by longitudinal striations.

*Locality*.—Off and east of Cape Morgan, 36 fathoms. Bottom: stones.

A long, simple, flagelliform colony, 50 cm. in length. The diameter near the base is 5 mm.; near the tip it is 4 mm. The coenenchyma is thick, being slightly over 1 mm. throughout. The general colour of the colony is a dull orange-red.

The polyps are distributed in two longitudinal series separated by two narrow bare tracts; there are four to seven alternating rows in each series. The verrucae are small and are closely adpressed to the coenenchyma, being sunk in pits so as to be almost level with it. They are very much retracted, however, and there is every reason to believe that when expanded they would be more than double their present length (fig. 84).

The members of one row irregularly alternate with those of the adjacent row.

The canal system is well developed, and is clearly seen in the thick coenenchyma; the two main canals are very large.

The axis is flexible, but very hard and densely calcareous; it is about 2.5 mm. in diameter near the base. The surface is marked by distinct longitudinal striae.

*Locality*.—Umhlangakulu River mouth, N.-W. by N.,  $7\frac{1}{2}$  miles; 50 fathoms. Bottom: sand, shell, and sponge fragments.

An almost complete colony, 24 cm. in length, of which only the base is wanting. This specimen is extremely interesting, as it shows to what extent the polyps may be extruded in this species.

The diameter of the stem is 4 mm. near the base, but diminishes gradually to 3 mm. near the tip. The coenenchyma is thick; the general colour of the colony is pale yellow; but the tips of the verrucae and the anthocodiae are white.

The present specimen agrees in detail with the last, except in the nature of the verrucae (cf. figs. 84 and 85).

*Locality.*—Off and east of Cape Morgan, 36 fms. Bottom: stones.

A beautiful, complete, simple colony, 22.5 cm. in length; the coenenchyma is moderately thick and densely granular; the general colour is a bright orange-yellow; but the tips of the verrucae and the anthocodiae are white, and there are also white streaks throughout the coenenchyma.

The polyps are distributed in two lateral, longitudinal series; the bare median tracts are fairly well defined. The number of rows in each series varies from two to four. The verrucae are sub-cylindrical, directed upwards, and adpressed to the stem (fig. 86). The members of two adjacent rows alternate with one another so that the tip of one verruca is on a level with the base of the next higher in the adjacent row. The verrucae are about 1.25 mm. in height and 0.75 mm. in diameter. Near the base they are much smaller, more distant, and a few are even sunk into pits in the coenenchyma. The anthocodiae are white; the tentacles are short, but have a dense aboral armature.

The canal system is typical and well developed; the two main canals are easily seen when a piece of the coenenchyma is detached.

The axis is slender, flexible, but very calcareous; the surface is marked by longitudinal striae.

*Locality.*—Umhloti River mouth, N. by W. half W., 8½ miles, 43 fms. Bottom: sand, shells, and hard ground.

A small, complete colony, 15.5 cm. in height; is almost identical with the last specimen.

The following differences may be noted:—

- (1) The colour is almost brick-red.
- (2) The verrucae are slightly smaller and are more adpressed to the coenenchyma. (Both these differences are probably due to greater retraction and to the fact that the colony itself is smaller.)

*Locality.*—Umhloti River mouth, N. by W. half W., 8½ miles, 40 fms. Bottom: sand, shells, and hard ground.

In the Littoral Collection of the Indian Museum there are four filiform colonies which have the characteristic spiculation of *S. furcata*, to which species we have therefore assigned them. They differ considerably in

external appearance, so that the following notes and figures (figs. 88 and 90) give some idea of the fertility of variation. Let us commence with those in which the verrucae are most contracted.

A long, simple filiform colony, 82 cm. in length, and having a maximum diameter of 2.5 mm. The coenenchyma is finely granular, and only 0.25 mm. in thickness near the base. The colour of the colony is a pale orange-yellow; but the tips of the polyps are reddish.

The verrucae are small and wart-like; when retracted they are sunk into the coenenchyma, and show an octoradiate structure (figs. 88*a* and 88*b*). The polyps are disposed in two longitudinal series, with two or three transverse, irregular rows in each series. No polyps occur on the lower basal part of the colony. The polyp-bearing areas are separated by two bare tracts, in one of which there is a distinct furrow, caused by the collapse of one of the main canals; the position of the other main canal is clearly visible owing to the extreme thinness of coenenchyma.

The verrucae are about 1 mm. in diameter.

The canal system is well marked and is quite typical of the group. The canals themselves are all very large.

The axis is cylindrical, dark brown at the base, where it is about 1.5 mm. in diameter; and pale yellow in the upper portion, where it is hair-like in fineness. The surface is marked by indistinct longitudinal furrows and ridges. Fig. 89 shows the chief types of spicules.

*Locality.*—Off Malabar Coast, 36 fms.

A small, complete, simple colony, 27 cm. in length, from the Andamans, also occurs in the Indian Museum Littoral Collection. It is of a creamy-white colour, and is almost uniform in thickness throughout; it agrees in detail with the last specimen from the Malabar Coast, except that each transverse row has only one polyp or occasionally two polyps. The axis is of a straw colour throughout.

The spicules are identical with those described for the other specimens.

*Locality.*—Andamans.

Two slender colonies, of a creamy-white colour, with projecting wart-like verrucae. The smaller colony is complete, and is 39 cm. in length; it is 2.25 mm. in diameter near the base (without verrucae), and about the middle of the colony; the basal portion which is present is 47 cm. in length. The diameter at the base is 2.75 mm., while at the broken end it is 4 mm.

The coenenchyma is granular, and moderately thin; it is creamy-white in colour.

Polyps do not occur for a considerable distance from the base; thereafter they are separated into two longitudinal series by two sinuous depressions

(fig. 90*b*); the two series approach so closely together as to appear as if merged into one, covering the whole of the coenenchyma, especially towards the middle of the colony. The verrucae are low, broad, and mound-like; they are sometimes 2.5 mm. in diameter at the base. Towards the base (fig. 90*a*) they are almost level with the coenenchyma; while near the tip they are often sunk into depressions in the coenenchyma (fig. 90*c*). The opening is circular, sometimes elongated, and has eight lips around it, giving a very definite pattern.

The canal system is typical; the two main canals are large. The axis is brown at the base, but yellow in the younger part; it is composed of concentric laminae, and is markedly calcareous. There are definite longitudinal striae, especially in the older part. Fig. 91 shows the predominant spicular types.

*Locality*.—Off Malabar Coast, 36 fms.

Amongst the *Alcyonaria* collected by the writer in the Mergui Archipelago, Burma, there are six specimens which undoubtedly belong to this species. Five of these are long and flagelliform, and represent a series in development; they are very slender, and taper only slightly from base to apex. The following measurements will serve to illustrate the most salient features:—

Specimen.	Total length of colony.	Diameter of colony at base.	Diameter of colony midway.	Diameter of axis at base.	Colour.
I.	27 cm.	1.75 mm.	1.5 mm.	1 mm.	Creamy-white, but yellowish towards base.
II.	42 cm.	3 mm.	2.5 mm.	1.25 mm.	Creamy-white
III.	61 cm.	3.75 mm.	3 mm.	2 mm.	Pale creamy-white.
IV.	86 cm.	2.75 mm.	2.75 mm.	2 mm.	Creamy-white.
V.	117 cm.	4.5 mm.	3.25 mm.	3 mm.	Dull white.

The coenenchyma is very thin, as may be seen from the above measurements; it is finely granular and very compact.

The mode of distribution of the polyps is very pronounced. Two of the specimens, (namely, I. and IV.) bear the disk of attachment, so that in these the arrangement may be studied from the base. The lower portion, for a considerable distance, is devoid of polyps; in the polyp-bearing region of the colony the verrucae are distinctly separated into two series by two longitudinal bare spaces, whose position is sometimes indicated by depressions.

This is especially marked towards the tip; but the depressions are continued very visibly along the non-polyp-bearing basal portion of the coenenchyma.

The number of verrucae in a transverse row in each of the two series varies according to the position in the colony. Towards the middle of the colony as many as six may occur; but this number decreases both towards the base and the apex, in each of which two or even one is the common number. Young forms occur scattered throughout the other verrucae, and the distribution is then very difficult to determine.

The verrucae are very minute and wart-like; when retracted, they are slightly sunk into the coenenchyma, and present a distinct eight-rayed figure which simulates a pseudo-operculum. In some cases they protrude slightly, and give the surface of the colony a faintly undulating appearance.

The axis is composed of concentric laminae, and is markedly calcareous; the surface varies in colour from black, through brown to pale yellow, according to its age. It tapers only very slightly.

The canal system is well developed; even in these slender specimens a cross-section, when viewed with a hand-lens, reveals the two longitudinal series. The part of the coenenchyma between these two series is very small compared with the outer non-canal-bearing part. The two main canals are extremely large in proportion to the others; and to this is due the very obvious longitudinal depressions even in the non-polyp-bearing part.

*Locality*.—Mergui Archipelago, Burma.

***Scirpearia furcata* var. *robusta*.** Figs. 92–96.

We have examined two characteristic colonies, one from the Indian Museum Littoral Collection and one from the Mergui Collection. These exhibit certain differences from the other specimens of *furcata*, but for the present we would consider them as a variety of *furcata*.

The colony in the Indian Museum Littoral Collection is complete with its basis of attachment; it is 20 cm. in height and 3 cm. in breadth, and consists of a main stem from which a branch of 6·5 cm. in length arises at a distance of 6 cm. from the base (fig. 92). A second branch arose 1 cm. from the first; but this has been broken at the point of origin. The diameter of the main stem near the base is 4 mm.; near the tip it is 3·5 mm. The two branches seem to arise in planes perpendicular to one another. The stem and branch are cylindrical.

The coenenchyma proper is finely granular and thin, never attaining a

thickness of over 1 mm., but about 0.5 mm. near the base. Near the tip of the main stem it has been rubbed off.

The general colour of the colony is brick-red.

On superficial examination the polyps appear to be distributed over the whole of the coenenchyma: but a minute inspection reveals a disposition in two longitudinal series separated by a sinuous line in the lower portion: this is more marked in the upper half and in the branch where a distinct depression is visible. No polyps occur on the basal 1.5 cm.

The verrucae are large and dome-like; they are about 2 mm. in diameter and 1.25 mm. in height. There is a trace of an eight-rayed structure at the summit (fig. 93). They vary very little in the different parts of the colony.

The canal system is typical; the two large main canals are very distinct.

The axis is cylindrical, very calcareous, and gives great rigidity to the colony; it is composed of concentric laminae. The colour varies from brown in the lower portion to pale yellow near the tip. The diameter near the base is over 3 mm.; it does not taper very markedly until it approaches the tip. The surface is marked by indistinct longitudinal striae.

The spicules (fig. 94) consist of double-clubs and elongated double-spindles, which in some cases approached the spindle type.

The following are the chief types, with measurements, length by breadth, in millimetres:—

- (a) Double-clubs with a short constriction and with the warts somewhat regularly disposed:  $0.08 \times 0.04$ ;  $0.073 \times 0.046$ ;  $0.07 \times 0.042$ .
- (b) Smaller double-clubs with the warts nearest to the constriction arranged in a whorl:  $0.06 \times 0.034$ ;  $0.045 \times 0.025$ .
- (c) Elongated double-spindles with irregular disposed warts:  $0.1 \times 0.035$ ;  $0.095 \times 0.03$ ;  $0.09 \times 0.03$ ;  $0.08 \times 0.025$ .
- (d) Spindles (like type (c), but with no constriction):  $0.09 \times 0.025$ ;  $0.08 \times 0.02$ .

Types (c) and (d) are more abundant in the verrucae. Very characteristic is the occurrence of a large number of conically shaped elongated double-clubs and spindles.

*Locality.*—Andamans.

Another very characteristic, complete, simple colony, 17 cm. in length, occurs in the Mergui Collection. Externally it recalls the projecting-verrucae type of *Juncella juncica*; but the nature of the spiculation precludes this possibility. The disk of attachment is present. The diameter at the base, without verrucae, is 2 mm.; it increases in thickness very markedly.

so that near the middle of the colony it is 5.5 mm. (including verrucae); from this position to the tip it decreases, so that midway it is only 3.5 mm., while the apex itself is distinctly pointed (fig. 95).

The coenenchyma is finely granular, and, except near the base and towards the tip, it is very thick. About the middle of the colony, where the diameter of the axis is 0.75 mm., the coenenchyma is 2 mm. in thickness.

The colour of the colony is creamy-white.

The verrucae are dome-like; but the oral opening is directed slightly upwards; they are about 1 mm. in height and 1 mm. in diameter at the base. The colour is markedly flattened throughout its entire length; on each of the two flattened surfaces there is a very deep groove; these separate the polyps into two longitudinal series. In each series there is a varying number of polyps; near the base there are four transverse rows; towards the middle of the colony there are five; while from this point the number diminishes, so that near the apex there is a single row in each series. Young forms occur amongst these, however, and break the fundamental symmetry.

The canal system is well marked; the two main canals corresponding to the two longitudinal grooves are very large; in this and other respects it is characteristic of the group.

The axis is very slender; at the base it is only slightly over 1 mm. in diameter; from this it tapers gradually to an almost hair-like fineness at the tip. It is black in colour near the base, but passes through pale brown to yellow near the apex.

The spicules (fig. 96) are almost identical with those in the previous specimen, both in types and measurements.

*Locality*.—Mergui Archipelago, Burma.

#### XXVI. *Scirpearia andamanensis* n. sp. Figs. 97-101.

This new species is established for a very distinctive specimen in the Littoral Collection in the Indian Museum.

The colony is 17 cm. in height and 9 cm. in maximum breadth; it is laxly branched in one plane. The branches arise in an irregular and sub-alternate manner, and are considerably elongated. The basis of attachment is broken off at what is evidently a short distance from the actual base. (The colony is shown complete in fig. 97.)

The stem and branches are cylindrical, and taper very slightly. The coenenchyma is about 1 mm. in thickness; and this is almost constant

throughout the colony, being slightly thinner in the older portions. The surface is finely granular.

The general colour of the colony is ochreous-yellow; but the tips of the verrucae and the anthocodiae are white.

The polyps are distributed in two longitudinal series situated laterally—that is, on the aspects perpendicular to the plane of ramification. In each series there are from three to four irregular rows. The two bare spaces are quite distinct, and only here and there are median depressions to be seen.

The verrucae vary considerably according to the stage of retraction. When expanded they are mammilliform, are directed upwards, and adpressed to the coenenchyma. This is well seen near the tips of some of the smaller branches where the coenenchyma is relatively thicker and where they are depressed into the coenenchyma (fig. 98). When partially retracted they are wart-like or sometimes like short truncated cones standing perpendicular to the coenenchyma (fig. 99). When still further retracted they appear as small rounded projections or may be even sunk beneath the surface of the coenenchyma (fig. 100).

In all stages an eight-rayed figure is discernible. They are about 1 mm. in diameter, and may attain a height of over 1 mm.

Two large main canals corresponding in position to the bare tracts are plainly visible in a cross-section. The small canals are very numerous owing to the large number of the polyps in a transverse row.

The axis is cylindrical and calcareous. It is about 3 mm. in diameter at the base, but gradually tapers to an almost hair-like fineness. It is composed of concentric laminae. The surface is greenish-brown in colour, but towards the centre it is whiter owing to the greater amount of calcareous matter; there are indistinct longitudinal striae.

The spicules (fig. 101) are pale yellow or colourless; they consist of the following types, of which the measurements in millimetres are given:—

- (a) Large double-clubs, with almost hemispherical ends, and a very short median constriction:  $0.07 \times 0.035$ ;  $0.07 \times 0.03$ ;  $0.065 \times 0.04$ ;  $0.06 \times 0.04$ .
- (b) Smaller double-clubs with more openly warted heads and a longer constriction:  $0.045 \times 0.03$ .
- (c) Elongated double-clubs with comparatively few irregularly distributed warts:  $0.08 \times 0.023$ ;  $0.08 \times 0.02$ ;  $0.06 \times 0.015$ .
- (d) Spindles (these may be modifications of type (c) in which the constriction is not visible):  $0.09 \times 0.02$ .

*Locality.*—Andamans.

XXVII. *Scirpearia ramosa* n. sp. Figs. 102-104.

In the Littoral Collection of the Indian Museum there occurs a very beautiful and characteristic branched colony for which it has been necessary to establish a new species. The mode of branching, the nature of the verrucae, and the distinctive character of the spicules, are all features of great importance. The colony is complete with its basis of attachment; it is 14 cm. in height and about 9.5 cm. in maximum breadth, and is branched irregularly in one plane. The majority of the branches arise at nearly right angles; they are long, and may ascend for a considerable distance without giving rise to finer twigs. They vary very little in diameter throughout their entire length (fig. 102). They are flattened in the plane of ramification, so that a cross-section is elliptical. The diameter of the main stem is 2.5 mm., but some of the branches are 3 mm. in their longer and about 2 mm. in their shorter diameter.

The coenenchyma has a very granular surface; it is 1 mm. in thickness towards the tip of the branch, but considerably less in the older parts where the axis is thicker.

The colour of the colony in spirit is yellowish-red; but the verrucae are of a more decided reddish tint, and streaks of red pass indefinitely from them, and gradually merge into the general tone of the coenenchyma. When dry the whole colony is almost ochreous yellow.

The polyps occur on the branches, but not on the main stem; they are distributed in two distinct series on the sides, or non-flattened aspects, of the branches; but occasionally they encroach on the flattened surfaces. There are thus two very distinct bare longitudinal zones.

The verrucae have the appearance of very low truncated cones, and are almost crater-like; they hardly project beyond the coenenchyma. This is due to their great contractility, as is evident from the shrunken appearance. They are about 0.5 mm. in height and 2 mm. in diameter at the summit. The oral opening is very large; it is circular in outline, and the eight retracted tentacles apparently form a pseudo-operculum (fig. 103).

The canal-system is typical of the group; the two main canals are very large, and correspond to the bare tracts. On several of the branches there is a distinct longitudinal furrow indicating their exact position.

The axis is cylindrical, and is composed of definite concentric laminae; a cross-section shows lines radiating from the centre to the circumference. The outer more horny portion is brown in colour, but the more calcareous central part is white. The surface is marked by longitudinal ridges and furrows, the number of which varies according to the portion of the colony examined. Two

of the furrows, larger and deeper than the others, correspond in position to the two large main canals.

The spicules consist essentially of double-clubs; but these may be elongated and narrow, and with so short a constriction as to appear like warty spindles. The warts are large and close-set. The spicules are either pale yellow or colourless. In the coenenchyma there are only double-clubs, with warty, hemispherical heads, and a short constriction. The following measurements, in millimetres, are typical:—

$$0.07 \times 0.05; 0.07 \times 0.045.$$

$$0.05 \times 0.03; 0.04 \times 0.025.$$

The spicules of the polyps are, on the whole, longer and narrower than those of the coenenchyma. They are

- (1) Double-clubs, with warty, slightly elongated heads, and with a short constriction:  $0.09 \times 0.02$ ;  $0.08 \times 0.02$ ;  $0.06 \times 0.025$ .
- (2) Thicker double-clubs, more like those of the coenenchyma:  $0.08 \times 0.035$ .
- (3) Warty spindles (occasionally a constriction is discernible):  $0.07 \times 0.02$ .

*Locality*.—Andamans, 20 fms.

*Specific Diagnosis.*

Colony branched in one plane; most of the branches arise almost perpendicularly, but soon turn upwards; they are flattened in the plane of ramification, vary very little in thickness throughout their entire length, and terminate bluntly. The polyps are distributed for the most part on the non-flattened aspects of the branches, and stand perpendicularly; the verrucae, when retracted, have the form of low, truncated cones, and may even appear almost level with the coenenchyma. The oral opening is closed by the inturned tentacles, which thus form a pseudo-operculum. The spicules consist essentially of (1) broad double-clubs, with a short constriction and almost hemispherical ends; (2) elongated, broad double-clubs, with *very rounded ends*, and with the same character as the previous type; and (3) longer and narrower double-clubs, which may approximate double-spindles, and eventually spinules.

XXVIII. *Scirpearia ceylonensis* n. sp. Figs. 105-107.

Among the Alcyonaria collected by Professor Herdman in Ceylon is a beautiful branched specimen which was not described in the general report. It has been found necessary to establish a new species to include it.

The total height of the colony is 31 cm.; it consists of a main stem 30 cm. in height, from which four branches arise, all on one side. The first arises at a point 4 cm. from the base; and the others after 2·5, 3, and 10 cm. consecutively. The lowest branch is broken, and is 13 cm. in length, but was evidently much longer; the others are 5·5, 10, and 15 cm. respectively (fig. 105).

The main stem after the origin of the first branch and all the branches are markedly flattened in the plane of ramification.

The diameter of the main stem near the base is 2 mm., and its greatest breadth in the flattened portion 3 mm. The branches vary considerably in thickness. The colour of the colony is a pale orange-yellow; but the verrucae are more reddish. The coenenchyma has a very granular surface; it is nearly 1 mm. in thickness in the branches, but thinner in the older parts, where the axis is proportionately larger.

The polyps occur on the branches and also on the main stem, except on the portion below the origin of the first branch; they are distributed in two longitudinal series on the sides of the branches; the flattened aspect is broad, and quite devoid of polyps. In each series this is a single row; but overcrowding or the interposition of young forms sometimes obliterates the symmetry (fig. 106).

The verrucae, when retracted, are low, truncated cones, and often show very distinct wrinkling; they project very little beyond the coenenchyma. Many of the anthocodiae are only partially withdrawn; and the infolded tentacles appear to form a cone; on further retraction their bases form a horizontal pseudo-operculum, and the verrucae present a very shrunken appearance. The tentacles are eventually quite covered up by the intumed sides of the verrucae.

The canal system is typical and well defined; the two main canals, corresponding in position to the bare tracts, are large; and a depression is sometimes visible owing to a collapse of the walls.

The axis is thin, cylindrical, composed of concentric laminae, and markedly calcareous. It is yellow in colour; and the surface is striated, two grooves slightly larger than the others being seen in some places.

The spicules (fig. 107) consist of the following types, with measurements, length by breadth, in millimetres.

- (a) Double-clubs, with a short constriction and with almost hemispherical heads, very irregular in outline, covered with few large warts:  
 $0\cdot08 \times 0\cdot042$ ;  $0\cdot076 \times 0\cdot046$ ;  $0\cdot076 \times 0\cdot42$ .
- (b) Elongated double-clubs, with rounded ends, and openly-warted:  
 $0\cdot08 \times 0\cdot038$ ;  $0\cdot08 \times 0\cdot034$ .

- (c) More elongated double-clubs, merging into double-spindles. The warts on these are sometimes disposed in whorls:  $0.084 \times 0.027$ ;  $0.082 \times 0.03$ ;  $0.082 \times 0.026$ .

From these measurements it will be seen that there is very little difference in the lengths of the various types, but that the breadths diminish proportionately more than the lengths. Intermediate forms also occur.

*Locality*.—Off Galle, Ceylon.

XXIX.—*Scirpearia maculata*. Figs. 108 and 109.

*Ellisella maculata* Studer, xxxiv., p. 629, Taf. iv., fig. 27 (*a*, *b*, and *c*).

*Ellisella maculata* (pars) Wright and Studer, l., p. 160, Pl. xxxiv., fig. 9.

*Ellisella calamus* Studer, xxxiv., p. 660, Taf. v., fig. 28 (*a*, *b*, *c*, *d*, and *e*).

*Ellisella calamus* Ridley, xxxiii., p. 348.

It is with considerable hesitation that we still recognize this species as distinct. It has been impossible, however, to examine the type specimen of the species; but we have seen a Banda specimen in the British Museum, of which Professor Bell has sent me a photograph (fig. 108). The other specimen, from the Torres Straits, described in the "Challenger" Report, has proved, on examination of the spicules, to be *Juncella gemmacea*.

There can be no doubt, however, that *Ellisella calamus* is the same as *Ellisella maculata*, since in spiculation they are identical, and the macroscopic characters on which they are separated are only variational differences. This will be evident from the following description. Studer, in describing *E. maculata* says:—

The stem is cylindrical, forked, divided into only a few long cylindrical branches. The colony is 5 cm. in height; the diameter of the stem is 5 mm., that of a branch 3 mm. One of the branches is 13 cm. in length.

The stem and branches are covered with verrucae, which hardly project; these occur laterally, on the thicker branches, in several rows, leaving a narrow, shallow median space, which disappears in the twigs. The verrucae have a circular opening. The spicules are (1) double-clubs, 0.095 mm. in length; and (2) a few warty spindles, 0.084 mm. long.

The colour of the coenenchyma is orange-red; the verrucae are dark red.

*Locality*.—Mermaid Straits, North-West Australia, 50 fms.

In separating *E. calamus* from *E. maculata* he gives the following diagnosis of the former:—

Simple, rod-like, cylindrical stem. The length of the largest specimen is 80 cm. The maximum diameter is 2 mm. The axis is horny and

calcareous, with alternate horny and limy rings, flexible, yellowish. The cortex is fairly thick. The verrucae project as pointed cones only in the upper portion. They occur on the sides of the stem in quincunx, in several rows, leaving a narrow, shallow, smooth space, which gradually becomes narrower till it disappears in the terminal portion.

The spicules are like those of *maculata*, namely, spiny double-clubs and spindles (0.06).

*Locality*.—Mermaid Straits, 50 fms.

Ridley (xxxiii, p. 348), in identifying a specimen in the "Alert" Collection with *E. calamus*, gives the following notes:—

A specimen 9 inches (225 cm.) long; incomplete. The colour is dark brick-red. The fusiform spicules were almost twice as long as those of Studer's specimen. He says nothing of the dimensions of the double-clubs.

*Locality*.—Port Denison, Queensland, 4 fms.

The following notes from the "Challenger" specimen in the British Museum (fig. 108) may be of interest:—The fragment is 50 mm. in length, and has a diameter varying from 3.5 mm. at the base and 2 mm. near the tip. The coenenchyma is about 1 mm. in thickness throughout; the canal system is typical of the group, and there are two distinct main canals which define two longitudinal bare spaces, although Wright and Studer refer to only "a very narrow median groove."

The polyps are disposed in two longitudinal series; but a torsion of the whole colony has resulted in a false spiral appearance. The verrucae are small and dome-like; some are adpressed to the stem; while others are almost retracted within the coenenchyma.

The axis is of the typical Juncellid structure.

Wright and Studer thus define the spicules, of which the chief types are shown in fig. 109:—

"The spicules consist of (1) salmon-coloured spindles,  $0.12 \times 0.04$  mm.;  $0.08 \times 0.02$  mm. (2) sherry-coloured double-clubs:  $0.1 \times 0.06$  mm.;  $0.06 \times 0.04$  mm. (3) Needles:  $0.06 \times 0.02$  mm.

*Locality*.—Banda Islands.

*Note*.—Fig. 110 of the Torres Straits specimen of *Juncella gemmacea*, which was originally described as *Ellisella maculata*, has been added here to illustrate convergence in the group, and show how futile it is to attempt to separate Juncellids into genera without an examination of the spicules.

### XXX. *Scirpearia quadrilineata* n. sp. Figs. 111–113.

It has been found necessary to establish this new species to include a very distinctive specimen in which the most predominant feature is the presence

of *four* main longitudinal canals, and the consequent distribution of the verrucae in *four* longitudinal series.

The colony is complete, simple, and flagelliform; the basis of attachment is conical, covered with coenenchyma, and spread over a piece of rock. The total height of the colony is 35 cm.; the diameter at the base is 4.5 mm.; near the tip it is 2 mm.

A very noticeable feature in the general appearance of the colony is the fact that it is markedly square in section.

The coenenchyma is thin; near the base it is 0.75 mm. in thickness; but near the tip it approaches 1 mm. Around the periphery of the axis there is a system of longitudinal canals, of which *four* are markedly larger than the others; these are arranged symmetrically, equidistant from one another, and thus forming the corners of a square (fig. 111). No outer system of longitudinal canals was visible; but the coenenchyma is so thin that these may be easily overlooked. It is extremely difficult to cut through the coenenchyma without damaging it, so that it is quite possible that these are present.

The polyps are disposed in a very characteristic fashion. They are grouped in *four* definite longitudinal series, separated by four bare spaces which correspond in position to the four main canals (fig. 112). Each series consists of a single row; but near the middle of the colony they are somewhat crowded, and give an appearance of two rows, due in great part to displacement.

Near the base and towards the tip they are more openly arranged, but always in four series.

The verrucae are low and dome-like, and have a maximum height of 0.5 mm. Towards the tip of the colony and near the base they tend to become almost level with the coenenchyma; while the extreme basal portion is quite destitute of polyps. When partially closed they show a very distinct eight-rayed figure. The anthocodiae are very small, and are all retracted within the verrucae.

The axis is made up of concentric laminae; it is extremely limy and very hard; the colour of the outside is brown, but the core is white; the surface is marked by faint longitudinal striae. Near the base the diameter is 3 mm.; but towards the tip it becomes almost hair-like and less limy.

The spicules are quite distinctive. We have figured six types (fig. 113).

- (a) Double-clubs with very densely warted and regular heads; the constriction is very short; and the warts are symmetrically arranged:  $0.06 \times 0.05$ ;  $0.076 \times 0.049$ ;  $0.076 \times 0.046$ .

- (b) Smaller double-clubs, with a longer constriction, with more open heads, and with the warts less symmetrically arranged:  $0.06 \times 0.034$ ;  $0.05 \times 0.031$ ;  $0.049 \times 0.027$ .
- (c) Elongated double-clubs, tending towards double-spindles, with rounded blunt ends:  $0.091 \times 0.038$ ;  $0.087 \times 0.034$ ;  $0.083 \times 0.034$ .
- (d) Elongated double-spindles, with pointed ends, and with a definite constriction:  $0.118 \times 0.034$ ;  $0.114 \times 0.031$ ;  $0.114 \times 0.023$ ;  $0.103 \times 0.023$ .
- (e) Long spindles with a hint of constriction:  $0.125 \times 0.023$ ;  $0.114 \times 0.031$ .
- (f) Shorter spindles also with a hint of constriction:  $0.095 \times 0.019$ ;  $0.087 \times 0.015$ ;  $0.016 \times 0.023$ .

We have little hesitation in defining (a), (b), and (c) as distinct types; but it is just possible that (f) might develop into (e) or (d) according as increase with growth was greater in length or in breadth. So many of each kind occur, however, that we feel justified in defining them as separate for the present, at any rate, until more is known with regard to their growth.

The colour of the coenenchyma is a bright orange-red—but the tips of the verrucae are more reddish.

*Locality*.—Laccadives, 30–40 fathoms.

Diagnosis, colony simple; spicules contain double-clubs and double-spindles, with transitions to spindles. The coenenchyma is thin, and contains *four* main longitudinal canals. The verrucae are disposed in *four* definite longitudinal series, separated by four bare tracts, which correspond in position to the four main canals. The colony is markedly square in section.

### XXXI. Genus *Nicella* emend.

#### (A) *Discussion of the Genus*.

This genus was established by Gray in 1870 (Cat. Lith. Brit. Mus., p. 40) in the following terms:—

Coral fan-like, in one plane, branched; branches forked, rather diverging. Bark smooth, brown. Polyp cells cylindrical, truncated, diverging from the stem at nearly right angles; mouth open. Axis calcareous, white solid.

To this genus he refers a specimen under the name *Nicella mauritiana*, and gives as a synonym his previous *Scirpearia dichotoma* (P.Z.S., 1859, 481–2).

Ridley (xxix., p. 130) identified a specimen from Mauritius under the name *Nicella dichotoma*, and made the following observation on the spicules: "There is a dense cortical layer of small double-heads and a subjacent

layer of longer densely tuberculate spindles, having a bare median space more or less clearly indicated."

Wright and Studer, with these facts as a basis, give the following diagnosis:—

"The colony is upright, branched, with a thin coenenchyma and protruding verrucae, which arise perpendicularly, and appear to be terminally truncated. The polyps arise from either side of the stem and branches, leaving a middle space free. The spicules form a cortical layer of small double-clubs and an internal layer of long densely warted spindles."

The following species have been from time to time referred to this genus:—

- N. dichotoma* (Gray).
- N. mauritiana* (Gray).
- N. laxa* Whitelegge.
- N. flabellata* (Whitelegge).
- N. reticulata* Thomson and Simpson.
- N. pustulosa* Thomson and Simpson.

An examination of the type-specimen of *Scirpearrella moniliforme* Wright and Studer, in the Collection of the British Museum, has revealed the fact that this species should be included in the genus *Nicella*. Thomson and Henderson also referred *Verrucella flabellata* Whitelegge to this genus, so that the generic diagnosis has been emended to include these forms.

Thomson and Simpson (xli., p. 267) referred a specimen in the Littoral Collection of the Indian Museum to this genus under the name *Nicella pustulosa*, with the following reservation:—

"It is with some hesitation that we refer this type to the genus *Nicella*. It is a matter of no small difficulty to distinguish between *Nicella*, *Gorgonella*, and *Verrucella*. . . .

"Our specimens approach *Nicella* in several respects, though agreeing with none of the described species; and as the positive characters of the other genera are absent, we feel justified in making a new species to include these forms."

The present study of this genus has, however, convinced me that the presence of the abnormally large spindles is a character which cannot be overlooked; so that, while still acknowledging the specific rank of the specimens under consideration, I would suggest their withdrawal from the genus *Nicella*, but until a revision of the species of *Verrucella* and *Gorgonella* has been made I would not hazard an opinion on their generic position. With

regard to the spicules of this group, we also made the following observation :—  
 “Distinctions based on spicules alone are very unsatisfactory in this group (Gorgonella and Verrucella), because the spiculation varies at different levels; and transition forms are so numerous and varied that it is sometimes almost impossible to distinguish between double-spheres, double-stars, and double-clubs, each in turn passing gradually to double-spindles. In Verrucella . . . there are double-stars; in Gorgonella . . . double-spheres occur.”

As I have elsewhere pointed out, I doubt very much the validity of these two genera, on the present spicular distinction, but await a revision of the known species for a solution of the difficulty.

(B) *Classification of the Species with emended Diagnoses.*

On this basis four species may be recognized, and are included in this report. These are :—

*N. dichotoma* Gray.

*N. flabellata* (Whitelegge).

*N. reticulata* Thomson and Simpson.

*N. moniliforme* (Wright and Studer).

The following short specific diagnoses may prove useful :—

*Nicella flabellata.*

The colony is branched in one plane; the smaller branches tend to arise from one side of the larger. The coenenchyma is moderately thin, and often presents a ridged appearance due to segregations of spicules. The polyps are disposed in two longitudinal series; in the younger part they occur in a sinuous row on either side of the branch; but in the older portions they are more numerous and may encroach slightly on the median bare spaces. The verrucae vary in shape and size according to the stage of retraction; when expanded they are prominent, and show an eight-rayed figure at the summit; when retracted they appear as low conical warts, and there is no trace of an octo-radiate structure. The axis is composed of concentric laminae; and the surface is marked by longitudinal striae.

The spicules consist of (1) small double-clubs, (2) small double-wheels, (3) elongated double-clubs, (4) long, massive, bluntly terminating double-spindles, (5) long, slender simple-spindles. (See fig. 115.)

*Nicella reticulata.*

Colony branched in one plane, with abundant anastomosis; the branches and twigs are very slender, so that the colony is extremely reticulate and flabelliform. The coenenchyma is thin and finely granular. The polyps are

disposed mainly in two longitudinal series; but deviations from this type occur, owing in some cases to overcrowding, in others to the anastomosis. The verrucae are usually low and dome-like. The spicules consist of (1) small double-clubs and elongated double-clubs, and (2) long double-spindles and simple-spindles. These two sets are quite distinct; but the spindles are not so disproportionate in length to the double-clubs as in most other species.

*Nicella mouiliforme*.

Colony simple or feebly branched, slender, filiform, and of almost uniform diameter throughout; polyps disposed in two longitudinal series, near the tip in one row, but in the older parts in two or more indefinite rows in each series. The spicules are very characteristic. They include small double-clubs and elongated slender double-clubs: also spindles of two kinds (1) *long, slender, spiny* spindles, and (2) *long, thick, densely warted* spindles. The spindles are sometimes more than twice as long as the typical double-clubs. (See figs. 117 and 118.)

XXXII. *Nicella dichotoma* Gray. Fig. 114.

*Scirpearia dichotoma* Gray, xi., p. 481.

*Nicella mauritiana* (Gray), xii., p. 40, fig. 12. non *Nicella mauritiana* Studer.

*Nicella dichotoma* Ridley, xxix., p. 130.

*Nicella dichotoma* Thomson and Russell, xliii., p. 161, Pl. VII., figs. 1 and 5.

*Nicella laxa* Whitelegge, xlix., p. 319, Pl. XVII., figs. 30-33.

This species was established by Gray in 1859 under the name of *Scirpearia dichotoma*. He defined it thus:—"Coral fan-like, in a single plane, irregularly dichotomous. Cells cylindrical, elongated, truncated, in a row on each side of the branches, sub-alternate." *Locality*.—Mauritius. In 1870 he formed another species, *Nicella mauritiana*, while he gave as a synonym *Scirpearia dichotoma*. Since this new species is the same as the older *dichotoma*, it was unnecessary to give it a new name, although he referred it to a new genus, so that the newer name must give way to the older. The description of *Nicella mauritiana* is as follows:—

"Coral fan-like, dichotomously branched; stem cylindrical, longitudinally striated; bark thin, pale brown; cells elongate, cylindrical, longer than the diameter of the stem, ascending, truncated at the tip, placed rather irregularly, sub-alternate (rarely sub-opposite) on each side of the stem and branches; axis pale greyish-brown." *Locality*.—Mauritius.

Ridley in 1882 re-identified the species, and described some specimens

from Mauritius, giving some positive, additional characters. One of his specimens was 340 mm. in height, and 240 mm. in maximum diameter. He says:—"The shape of the verrucae varies considerably according as to whether they are open or closed; in the former condition they are rectangular at the apex, while in the latter they appear conical with rounded apices. The basal diameter may vary from 1.25 mm. to 2.25 mm. when closed. The spicules consist of a dense cortical layer of small double-heads and a sub-jacent layer of longer densely tuberculate spindles having a bare median space more or less strongly indicated. The colour is variable, (1) ochreous yellow to a dull flesh colour, (2) dirty white."

In 1897 Whitelegge established a new species under the name *Nicella laxa* with the following characters:—"The colony is feebly branched; the branching is lateral and in one plane. The axis is laminate and calcareous. The coenenchyma is thin, and when viewed with a lens presents a series of minute ridges, forming a network of raised lines, which are lighter in colour and consist of double-club spicules. The polyps are confined to the sides of the stem and branches in a single row on each side. The verrucae are large, alternate, and stand nearly at right angles; they are divided at the summit into eight lobes. The spicules consist of (1) short double-clubs with smooth or warty tubercles:  $0.1 \times 0.05$  mm.;  $0.07 \times 0.03$  mm.;  $0.05 \times 0.02$  mm.; (2) fusiform spindles with rather obtusely pointed ends and a spiny tuberculated surface:  $0.25 \times 0.06$  mm.;  $0.2 \times 0.05$  mm.;  $0.1 \times 0.03$  mm. Many of both kinds are a little flattened. The colour is a light mouse-grey.

He says:—"This species differs from *N. dichotoma* by its smaller and more distant polyps and by its lax method of branching."

We have already seen that neither of these two characters is of much taxonomic importance; and, taking into consideration Ridley's observations on the size of verrucae in different stages of retraction, we do not feel justified in ranking this as a distinct species. At the same time Gray gives a very good figure of his *N. mauritiana*, and the branching there is almost identical with that figured by Whitelegge. In Gray's figure also the distribution of the polyps varies in different parts of the colony, so that while in some branches they are more closely packed, in others they are quite as distant as in Whitelegge's figure. The spicules are identical with those described by Ridley; and the network of ridges described by Whitelegge, though not given in Gray's description, are unmistakably present in his figure. We therefore see no reason for ranking *N. laxa* as a separate species.

Thomson and Russell, 1909 (xliii., p. 161, Plate VII., figs. 1 and 5) describe some specimens as follows:—

Several colonies of chestnut-brown to umber-brown colour. The largest is

20 cm. in height by 8 cm. in maximum breadth, and consists of a main stem, with lateral branches, which are again repeatedly branched. For the most part the branching is in one plane; but this is not rigorously adhered to. On the main stem of one of the larger specimens there is a curious gall-like swelling from which branches arise on all sides.

The stem is 4 mm. in thickness at its base, and gradually tapers to 2 mm. at the ends of the branches. The axis is light brown in colour, and very calcareous. On the surface of the general coenenchyma, and on the verrucae there are irregular wavy longitudinal ridges, producing a characteristic bark-like appearance. Under the low-power microscope the texture seems finely arenaceous.

The verrucae are very prominent, rising more or less perpendicularly to a height of 2 mm. They occur on all sides of the stem; but in the upper parts of the branches a bilateral arrangement is well defined. At the apex of the verrucae there is an indication of eight lobes, from which the tentacles here and there project.

Another specimen, the basal part of a large colony, branches in a somewhat irregular fashion, and not rigidly in one plane. The verrucae are much less bilateral, especially near the base of the colony. Examination of the spicules shows that this may be referred to *N. dichotoma*.

*Locality*.—Salomon A, 65 fathoms; Salomon B, 60-120 fathoms.

**XXXIII. *Nicella flabellata* (Whitelegge). Fig. 115.**

*Verrucella flabellata* Whitelegge, xlix., p. 319, Plate XVII., figs. 34-37.

*Nicella flabellata* Thomson and Henderson, xl., p. 80.

This species was established by Whitelegge for a specimen from Funafuti, but was then included in the genus *Verrucella*. Thomson and Henderson, in identifying a specimen from the Indian Ocean with this species, concluded that it should really be referred to the genus *Nicella*; and in this we thoroughly agree. The spiculation is quite distinctively *Nicellid* in character; and, as these authors point out, the actual shape of the verrucae matters little in a generic diagnosis. As a matter of fact, the nature of the verrucae, as shown in the figure given by Whitelegge, is intermediate between that in *N. dichotoma* and the Indian Ocean specimen.

The notes following may serve to indicate the chief specific characteristic.

The colony is branched in one plane; the branches show a tendency to arise from one side. The axis is densely calcareous and is striated. A noteworthy feature is the presence of two distinct grooves corresponding in position to the two main canals.

The polyps occur in a sinuous row on each side of the younger branches ; on the stem and on the older portions of the branches they are more numerous, and encroach on the two bare, flattened surfaces, always leaving a slight median depression free. Those on opposite sides alternate. The verrucae may be slightly prominent or may appear as low conical warts. When partially retracted, they show an eight-rayed figure ; but when fully withdrawn, this is not evident. An average height may be taken as 1 mm.

The coenenchyma is of medium thickness, and may have ridges on the surface. The canal system is the typical Juncellid.

The spicules are essentially of two types, viz., small double-clubs and long thick double-spindles. The double-spindles are about four times as long as the small double-clubs. There are, however, in addition to these two types :—(1) some small double-wheels, with elongated warty hubs ; (2) elongated double-clubs ; (3) long slender spindles with practically no constriction. Very small short rods and spiny spindles occur in the tentacles.

The colour of the Funafuti specimen was yellowish-white ; that of the Indian Museum specimen was ochreous yellow and brownish-white.

XXXIV.—*Nicella reticulata* Thomson and Simpson. Fig. 116.

*Nicella reticulata* Thomson and Simpson, xli., p. 266, Plate iv., fig. 5 ; Plate viii., fig. 12.

This species was established by Thomson and Simpson (xli., p. 266) for specimens in the Indian Museum Littoral Collection. We have considered it advisable, however, to recapitulate the original description for the sake of completeness. A typical colony measures 27 cm. in height by 16 cm. in maximum breadth, and is attached by a very much broadened expansion. It consists of a main stem, only 2 cm. long, and measuring 4·5 mm. in diameter. At the distal end of the main stem four branches arise, two sub-opposite and two at slightly different levels, but all very close together. These diverge at varying angles, the two lower being almost horizontal, the other two also in the same plane of ramification. These ramify irregularly in one plane and anastomose freely, forming a large, almost semicircular, flabelliform mass, with very irregular meshes.

The coenenchyma is thin and compact, and presents a glistening arenaceous appearance. The colouring is very peculiar, being generally reddish-brown in the lower part of the colony, but gradually merging into slaty grey in the upper parts. Patches of grey appear throughout the red in some of the colonies, and *vice versa* ; while one colony from the Laccadives is almost uniformly of a brick-red colour. The surface bears longitudinal

furrows, which are sinuous, and sometimes almost spirally twisted; one being generally deeper than the others. These extend into the secondary branches, and even into one side of the twigs, the number diminishing with the size of the branches.

The axis is very calcareous and cylindrical in form. It is composed of concentric laminae, and has an almost olive-green colour at the base, gradually merging into a pale yellow in the smaller branches.

The polyps are disposed essentially in two longitudinal series; but deviations occur in several places, due sometimes to the anastomosis and sometimes to overcrowding. They are chiefly lateral on the main stem or primary branches; in the secondary branches they are arranged almost all round. On the finer branches and twigs they occur for the most part on two sides; but this rule is broken occasionally by the occurrence of polyps on all the four sides. The verrucae are dome-like, but slightly flattened on the twigs. They are separated by intervals of about 1 mm. in the branches; but their bases touch on the branchlets and give an undulating appearance. They measure about 0.5 mm. in height and 1 mm. in diameter. When the verruca closes over the retracted polyp, an eight-rayed star is formed by the eight lobes of the wall. The anthocodiae are very minute and are completely retractile; the spicules are arranged transversely on the tentacles.

The spicules of the coenenchyma consist of small double-clubs, elongated double-clubs, double-spindles, and simple-spindles. The double-spindles and simple-spindles in this species are not so markedly disproportionate as in most other species; but their distinctive character justifies their inclusion in the genus *Nicella*.

The following are a few of the more common types, with measurements in millimetres :—

(a) Double-clubs, with smooth warts :

0.05 × 0.04; constriction 0.02 broad × 0.008 long.  
0.048 × 0.04        „        0.02    „    × 0.005    „

(b) Elongated double-clubs, with fewer and more irregular warts :

0.06 × 0.04; constriction 0.03 broad × 0.01 long.  
0.048 × 0.035        „        0.02    „    × 0.012    „

(c) Spindles with round warts, and double spindles, having a smooth part in the middle :

0.09 × 0.025; smooth part, 0.02 long.  
0.085 × 0.028        „        „    0.018    „

(d) Minute crosses, with a very distinct cross, 0.04 × 0.04.

(e) Minute irregular crosses, elongated along one diagonal, with distinct cross, 0.05 × 0.03.

Those of the tentacles are short, warty rods :  $0.05 \times 0.015$ ;  $0.06 \times 0.015$ ;  $0.6 \times 0.015$ .

*Localities*.—Persian Gulf, 48–49 fms. Laccadives, 30–50 fms.

XXXV.—*Nicella moniliforme* emend. Figs. 117 and 118.

*Scirpearrella moniliforme* Wright and Studer, p. 156, Pl. xxxiv., fig. 8.

non. *Gorgonia moniliforme* Lamx., xxv., p. 420.

nec. *Scirpearrella moniliforme* Thomson and Henderson, xl., p. 82.

nec. *Scirpearia moniliformis* Gray xii., p. 39.

This species, as established by Wright and Studer in the "Challenger" Report, is a very distinctive one, based chiefly on the character of the spiculation.

The colony may be simple or feebly branched; the branched type-specimen was 505 mm. in length; and the branch arose at a distance of 215 mm. from the base; one of the unbranched forms was 325 mm. in length. The colonies are very slender and do not vary much in diameter throughout the entire length. The coenenchyma is thin and coarsely granular.

"The axis is very deeply grooved; ten grooves can be very easily counted on the older portion of the axis; but these diminish to two at the apex. These ridges show through the coenenchyma as linear furrows."

"The polyps are arranged on the stem, the lower portion in four irregular rows; towards the apex they are alternate and arranged on either side of the stem; while for the first 60 mm. of the stem, counting from the basal disk, they are absent. They are retractile within the well-marked but shallow verrucae; these latter measure at their base 1 mm. An occasional verruca will be found larger and more elevated than the rest, measuring 1.5 mm. in diameter and the same in height; these generally are to be found near the summit of the axis."

The disposition of the verrucae is in two longitudinal series; and the two bare tracts are marked by distinct furrows larger than the others. Unfortunately Wright and Studer give no figure of the colony itself; and, as the figure of spicules is somewhat misleading, we have thought it advisable to add to this memoir two figures from the type-specimen in the British Museum (figs. 117 *a*, *b*, and *c*).

The colour in spirit is white.

The nature of the spicules in this species and also their relative proportions are very striking, and mark it off as distinct. The following four types can easily be identified:—(*a*) long, comparatively slender spindles, covered with coarse spines or small warts; (*b*) long, thick spindles, very

densely warted; (c) slender double-clubs, with elongated conical ends, and with the constriction more or less marked; (d) *small* double-clubs, with almost hemispherical ends and with a definite smooth constriction: aberrant forms, such as crosses, (e) also occur. There are small needles in the anthocodiae.

The following measurements, length by breadth in millimetres, will give the relative proportions of these different types (see fig. 118):—

- (a) Spindles—long, thin spiny or with small warts:  $0.2 \times 0.034$ ;  $0.15 \times 0.026$ ;  $0.13 \times 0.02$ .
- (b) Spindles—long, thick and densely warted:  $0.15 \times 0.046$ ;  $0.13 \times 0.042$ .
- (c) Double-clubs—slender, with elongated ends, and with the constriction more or less markedly defined:  $0.11 \times 0.045$ ;  $0.099 \times 0.043$ ;  $0.087 \times 0.03$ ;  $0.065 \times 0.025$ .
- (d) Double-clubs—with massive ends, and with a distinct, short, smooth constriction:  $0.072 \times 0.042$ ;  $0.072 \times 0.038$ ;  $0.057 \times 0.038$ .
- (e) Crosses— $0.16 \times 0.11$ ;  $0.12 \times 0.12$ .
- (f) Needles—small (in anthocodiae):  $0.06 \times 0.011$ ;  $0.04 \times 0.02$ .

*Locality*—Amboina: 100 fathoms.

#### XXXVI. BATHYMETRICAL DISTRIBUTION.

The whole group is essentially littoral in its distribution. The great majority of the specimens hitherto described have been dredged within the hundred-fathom line; in fact, the only records outside this range are from (1) "Challenger" Station 232, known as the *Hyalonema*-ground off Japan, 345 fathoms; (2) "Challenger" Station 177 off the New Hebrides, 130 fathoms; (3) a dredging made by the "Investigator," off the Andamans in 124 fathoms; and (4) off the Azores, 150 and 200 fathoms.

At the first of these *Juncella racemosa* and *Scirpearia profunda* were obtained, at the second *Scirpearia profunda*, at the third only *Juncella racemosa*, and at the fourth only *Scirpearia flagellum*.

Consequently these are the only three species which can lay claim to deep-sea forms; and it is interesting that all the records of these species are from over 100 fathoms, and also that each has been found in distant localities over this depth. At the same time it is not improbable that these specimens occurred in deep water at the edge of an almost vertical reef, and that these were merely "escapes" from the reef.

Such records are not unknown; and the writer has experienced similar occurrences in the deep water off the almost perpendicular reefs on the east coast of Africa.

*Nicella moniliforme* is recorded from one hundred fathoms, and the only other records from over fifty fathoms are *Scirpearia thomsoni* and *Scirpearia alba*, both from 88 fathoms. The following table will give at a glance the chief records for each of the species in this report:—

SPECIES.	DEPTHS IN FATHOMS FROM WHICH RECORDED.
<i>Juncella juncea</i> , . . .	0·10; 4; 7-11; 15-35; 25-30; 45; 50.
<i>Juncella gemmacea</i> , . . .	0-8; 4; 8; 11; 19; 12-20; 32.
<i>Juncella racemosa</i> , . . .	120; 345.
<i>Juncella trilineata</i> , . . .	34.
<i>Scirpearia profunda</i> , . . .	130; 345.
<i>Scirpearia hicksoni</i> , . . .	36.
<i>Scirpearia verrucosa</i> , . . .	50.
<i>Scirpearia anomala</i> , . . .	?
<i>Scirpearia pectinata</i> , . . .	3-4; 12; 30.
<i>Scirpearia elongata</i> , . . .	
<i>Scirpearia flugellum</i> , . . .	90; 150; 200; 60-120.
<i>Scirpearia thomsoni</i> , . . .	88.
<i>Scirpearia alba</i> , . . .	88.
<i>Scirpearia aurantiaca</i> , . . .	30-50; 60-130; 120; 150; 130.
<i>Scirpearia furcata</i> , . . .	15. 20 . . . . . 30-40; 50-78.
<i>Scirpearia andamanensis</i> , . . .	?
<i>Scirpearia ramosa</i> , . . .	20.
<i>Scirpearia ceylonensis</i> , . . .	?
<i>Scirpearia maculata</i> , . . .	?
<i>Scirpearia quadrilineata</i> , . . .	30-50.
<i>Nicella dichotoma</i> , . . .	? 60-120.
<i>Nicella flabellata</i> , . . .	45.
<i>Nicella reticulata</i> , . . .	30-50; 48-49.
<i>Nicella moniliforme</i> , . . .	100.

It is quite probable, however, that when more inshore-work is carried on in tropical seas records will be abundant from water of much less depth than that at present given. Ridley in referring to the depths at which *Juncella gemmacea* occurs gives "between tide-marks," and, as has been already pointed out in the "Biological Note," it is no uncommon occurrence on the scattered coral reefs of the Mergui Archipelago to see at low spring tide huge colonies of *J. gemmacea* and *J. juncea* as well as *Melitodes* and other Alcyonaria swaying to and fro in the air.

## XXXVII. GEOGRAPHICAL DISTRIBUTION.

The great importance of the Geographical Distribution of even a small group of animals, but especially those whose early life is pelagic and whose adult life is sedentary, is becoming more and more evident. Such knowledge, combined with systematic oceanographical observations, may eventually help to solve many problems that at present are a source of great perplexity to the biologist.

It is premature to attempt such a distribution of Juncellids; but in view of the fact that in this memoir a general survey of the group, so far as it is known, has been given, and as the references to localities, especially in the case of the older species, are extremely scattered, the following summary may serve as a basis for a more detailed study when further records are forthcoming.

Although doubt may exist as to the specific determination of those species added as an appendix to the genus *Juncella*, it may be useful to include them here, inasmuch as they are in all probability Juncellids.

It has been considered inadvisable with the limited records at our disposal to draw any conclusions as to the dispersal of these organisms, as to their origin as a part of a littoral fauna, or as to the probability of their being originally indigenous in certain areas.

*Distribution of the Juncella-group of Gorgonellids.*

The *Juncella*-group of Gorgonellids occurs both in the Atlantic and Pacific waters, but almost entirely within the Tropics of Cancer and Capricorn, and also chiefly in the Pacific Ocean. The extreme records North and South are "Off Japan" and "Off Cape Colony." The following are the chief centres:—(1) Red Sea, (2) Persian Gulf, (3) Laccadives, (4) Maldives, (5) West Coast of India, (6) Ceylon, (7) Andamans, (8) Mergui, (9) Bourbon, (10) Mauritius, (11) Cape Colony, (12) East Indies, (13) Japan, (14) East Coast of Australia, (15) West Coast of Florida and in the Atlantic, (16) East Coast of Central America, (17) N.-E. of South America, (18) Azores, (19) Mediterranean Sea.

*Genus Juncella.*

This is the most widely distributed genus in the group, and is almost entirely a Pacific Ocean form.

*Genus Scirpearia.*

This genus is entirely restricted, with the exception of *S. flagellum*, so far as the present records show, to the Pacific Ocean.

*Genus Nicella.*

This genus is entirely restricted to the Pacific Ocean.

Let us now illustrate "associations of species" in different localities.

- (a) Laccadives, . . . *S. aurantiaca*, *S. quadrilineata*, and  
*N. reticulata*.
- (b) Maldives, . . . *J. juncea*, *S. furcata*.
- (c) Ceylon, . . . *J. gemmacea*, *J. trilineata*, *S. aurantiaca*,  
*S. ceylonensis*, *S. furcata*.
- (d) Andamans, . . . *J. juncea*, *J. racemosa*, *S. hicksoni*,  
*S. verrucosa*, *S. anomala*, *S. andamanensis*, *S. ramosa*.
- (e) Mergui, . . . *J. juncea*, *J. gemmacea*, *S. furcata*.
- (f) N.-E. Australia, . . . *J. juncea*, *J. gemmacea*.
- (g) Bourbon-Mauritius, . . . *J. juncea*, *J. gemmacea*, *N. dichotoma*.
- (h) Cape of Good Hope, . . . *S. flagellum*, *S. furcata*.

*References to various large Collections of Juncellids.***"CHALLENGER" COLLECTION.**

This collection was made by H.M.S. "Challenger," during her cruise round the world, 1873-76. The specimens are deposited in the British Museum, and were described by Wright and Studer in the Zoological Report of the "Challenger" Collections, vol. xxxi., pp. 153-181.

**DESCRIBED AS**

<i>Juncella juncea</i> , . . .	<i>Juncella juncea</i> , var. <i>alba</i> , p. 158.
<i>Juncella juncea</i> , . . .	<i>Juncella barbadensis</i> , p. 159.
<i>Juncella gemmacea</i> , . . .	<i>Juncella gemmacea</i> , p. 158.
<i>Juncella gemmacea</i> , . . .	<i>Ellisella maculata</i> (pars), p. 160.
<i>Juncella racemosa</i> , . . .	<i>Juncella racemosa</i> , p. 159.
<i>Scirpearia maculata</i> , . . .	<i>Ellisella maculata</i> (pars), p. 160.
<i>Scirpearia profunda</i> , . . .	<i>Scirpearella profunda</i> , p. 155.
<i>Scirpearia profunda</i> , . . .	<i>Scirpearella gracilis</i> , p. 156.
<i>Scirpearia profunda</i> , . . .	<i>Scirpearella rubra</i> , p. 157.
<i>Nicella moniliforme</i> , . . .	<i>Scirpearella moniliforme</i> , p. 156.

## "ALERT" COLLECTION.

This collection was made during the Surveying Voyage of H.M.S. "Alert," during the years 1881-82. The Gorgonellids were reported on by Ridley in "The Zoological Collections" of H.M.S. "Alert," 1884, pp. 345-349.

## DESCRIBED AS

<i>Juncella juncea</i> , . . .	<i>Juncella juncea</i> , p. 345.
<i>Juncella juncea</i> , . . .	<i>Juncella fragilis</i> , p. 347.
<i>Juncella gemmacea</i> , . . .	<i>Juncella gemmacea</i> , p. 346.
<i>Juncella gemmacea</i> , . . .	<i>Juncella elongata</i> , var., p. 346.
<i>Scirpearia pectinata</i> , . . .	<i>Otenocella pectinata</i> , p. 348.
<i>Scirpearia maculata</i> , . . .	<i>Ellisella calamus</i> , p. 348.

## CEYLON COLLECTION.

This collection was made by Professor Herdman in the Ceylon Seas in 1904 while investigating the Pearl Fisheries of the Gulf of Manaar. The type-specimens are deposited in the British Museum, and were reported upon by Thomson and Henderson, "Ceylon Pearl Oyster Report," Royal Society, 1905. Supplementary Report, No. xx., Aleyonaria, pp. 311-315.

## DESCRIBED AS

<i>Juncella juncea</i> , . . .	<i>Juncella juncea</i> , p. 314.
<i>Juncella juncea</i> , . . .	<i>Juncella gemmacea</i> , p. 313.
<i>Juncella juncea</i> , . . .	<i>Juncella fragilis</i> , p. 314.
<i>Juncella juncea</i> , . . .	<i>Juncella fragilis</i> , var. <i>rubra</i> , p. 314.
<i>Juncella trilineata</i> , . . .	<i>Juncella trilineata</i> , p. 315.
<i>Scirpearia furcata</i> , . . .	<i>Scirpearia</i> sp. (?), p. 313.
<i>Scirpearia furcata</i> , . . .	<i>Scirpearella</i> sp. <i>B.</i> , p. 312.
<i>Scirpearia aurantiaca</i> , . . .	<i>Scirpearella aurantiaca</i> , p. 311.
<i>Scirpearia aurantiaca</i> , . . .	<i>Scirpearella divisa</i> , p. 312.
<i>Scirpearia ceylonensis</i> , . . .	(undescribed).

## MALDIVE COLLECTION. 1.

This collection was made by Mr. Stanley Gardiner in 1900, and was described by Hickson in "The Fauna and Geography of the Maldive and Laccadive Archipelagoes," vol. ii., part iv. "The Aleyonaria of the Maldives," part iii., pp. 816-823.

## DESCRIBED AS

<i>Juncella juncea</i> , . . .	<i>Juncella juncea</i> , p. 820.
<i>Juncella juncea</i> , . . .	<i>Juncella flexilis</i> , p. 821.
<i>Juncella juncea</i> , . . .	<i>Juncella elongata</i> , p. 821.
<i>Scirpearia furcata</i> , . . .	<i>Scirpearia furcata</i> , p. 822.
<i>Scirpearia furcata</i> , . . .	<i>Scirpearia furcata</i> , var., p. 822.
<i>Scirpearia furcata</i> , . . .	<i>Scirpearella indica</i> , p. 822.
<i>Scirpearia furcata</i> , . . .	<i>Juncella elongata</i> (Val.), p. 821.

## MALDIVE COLLECTION. II. (described by Thomson and Russell, 1910).

## DESCRIBED AS

<i>Juncella gemmacea</i> ,	.	.	<i>Juncella gemmacea</i> .
<i>Scirpearia flagellum</i> ,	.	.	<i>Scirpearia flagellum</i> .
<i>Scirpearia aurantiaca</i> ,	.	.	<i>Scirpearia aurantiaca</i> .
<i>Nicella dichotoma</i> ,	.	.	<i>Nicella dichotoma</i> .

## MONACO COLLECTION. I.

The collections made by the Prince of Monaco, during the scientific voyage of the yacht "Hirondelle" in the North Atlantic Ocean, in 1886-88, contain several Gorgonellids. These have been reported upon by Studer, in "Resultats des Campagnes Scientifiques du Prince de Monaco," 1901, fasc. xx., pp. 52, 53.

## DESCRIBED AS

<i>Scirpearia flagellum</i> ,	.	.	<i>Scirpearia flagellum</i> , p. 53.
<i>Scirpearia flagellum</i> ,	.	.	<i>Scirpearia ochracea</i> , p. 53.

## INDIAN MUSEUM DEEP-SEA COLLECTION.

This Collection was made during the cruise of the old R. I. M. SS. "Investigator" in the Indian Ocean. The specimens are deposited in the Indian Museum, Calcutta, and were reported on by Thomson and Henderson, in the memoirs of the Indian Museum, Alcyonaria (1906).

## DESCRIBED AS

<i>Juncella racemosa</i> ,	.	.	<i>Juncella miniacea</i> , p. 81.
<i>Scirpearia profunda</i> ,	.	.	<i>Scirpearia moniliforme</i> , p. 82.
<i>Scirpearia alba</i> ,	.	.	<i>Scirpearia alba</i> , p. 82.
<i>Scirpearia thomsoni</i> ,	.	.	<i>Juncella elongata</i> , p. 81.
<i>Nicella flabellata</i> ,	.	.	<i>Nicella flabellata</i> , p. 80.

## INDIAN MUSEUM LITTORAL COLLECTION.

This Collection was made during the surveying cruises of the R. I. M. SS. "Investigator" in the Indian Ocean.

The type specimens are deposited in the Indian Museum, Calcutta. They were reported on by Thomson and Simpson, in the Memoirs of the Indian Museum Alcyonaria, 1909; but specific names were given only to a few;

descriptions of the others were tabulated, so that the following list will enable these to be identified.

	DESCRIBED AS
<i>Juncella juncea</i> , . . .	E. and F.
<i>Juncella gemmacea</i> , . . .	O.
<i>Juncella trilineata</i> , . . .	R.
<i>Scirpearia pectinata</i> , . . .	M.
<i>Scirpearia andamanensis</i> , . . .	N.
<i>Scirpearia anomala</i> , . . .	Q.
<i>Scirpearia aurantiaca</i> , . . .	B.
<i>Scirpearia furcata</i> , . . .	H, G, D, I.
<i>Scirpearia furcata</i> var. <i>robusta</i> , . . .	P.
<i>Scirpearia ramosa</i> , . . .	K.
<i>Scirpearia verrucosa</i> , . . .	C.
<i>Scirpearia hicksoni</i> , . . .	A.
<i>Scirpearia quadrilineata</i> , . . .	J.

#### WOOD-MASON COLLECTION.

This Collection was made by W. J. Wood-Mason in the Indian Ocean. A few of the specimens were described by Thomson and Simpson, but the majority of them were left over for incorporation in this paper. The types are deposited in the Indian Museum, Calcutta.

*Juncella racemosa*.  
*Juncella gemmacea*.  
*Scirpearia aurantiaca*.  
*Scirpearia furcata*.  
*Nicella flabellata*.

#### MERGUI COLLECTION. I.

This Collection was made by Dr. John Anderson for the trustees of the Indian Museum, Calcutta, where the specimens are deposited. They were described by Ridley in the Journal of the Linnean Society, vol. xxi., pp. 240-243.

	DESCRIBED AS
<i>Juncella juncea</i> , . . .	<i>Juncella fragilis</i> , var., p. 242.
<i>Juncella gemmacea</i> , . . .	<i>Juncella gemmacea</i> , p. 241.
<i>Scirpearia pectinata</i> , . . .	<i>Ctenocella pectinata</i> , p. 243.

## MERGUI COLLECTION. II.

This Collection was made by Simpson and Brown in the Mergui Archipelago, Burma, in the spring of 1907. The specimens are deposited in the Natural History Museum, Aberdeen University, and are reported on here for the first time.

They include the following species :—

*Juncella juncea.*  
*Juncella gemmacca.*  
*Scirpearia pectinata.*  
*Scirpearia furcata.*  
*Scirpearia furcata* var. *robusta.*

## AUSTRALIAN MUSEUM COLLECTIONS.

This Collection was made by Mr. C. Hedley for the Australian Museum, where the specimens are deposited. It was reported upon by Whitelegge in the "Memoirs of the Australian Museum XII.," The Alcyonaria, Part ii. (1897 ?), pp. 318–320.

## DESCRIBED AS

*Nicella dichotoma*, . . . *Nicella laxa*, p. 318.  
*Nicella flabellata*, . . . *Verrucella flabellata*, p. 319.

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<sup>1</sup> The Roman numerals correspond to the numbers given in the text.

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#### DESCRIPTION OF PLATES.

Fig.

1. Polyp of *Scirpearia pectinata* enlarged ( $\times 25$ ) to show structure.
2. Portion enlarged of Monaco specimen to illustrate the motility of the polyps.
3. Cross-section of a Juncellid axis to show the concentric laminae and the "ridges and depressions."
4. *a-g*. "Clubs" of *Juncella*, (*e-g*) showing characteristic variations.
5. *a* and *b*. Two kinds of double-clubs.
6. Variation forms of double-clubs.
7. Double-wheels or capstans.
8. Transition from the elongated double-club (*a*), through the double-spindle (*b*), to the simple spindle (*c*).
9. Three portions of var. *a*. of *Juncella juncea* to show the disposition and nature of the polyps, (*a*) near the base of the colony, (*b*) midway, (*c*) near the tip.
10. Cross-sections of var. *b*. of *J. juncea* to show the internal structure. The levels of (*a*), (*b*), and (*c*) correspond to those of fig. 9.
11. Three views of the superficial appearance of the axis in *J. juncea*. The portions shown are from the parts of the colony given in fig. 9.

## Fig.

12. Portions of *J. juncea* var. b. to show the distribution and nature of the verrucae, (a) near the base, (b) midway (non-polyp-bearing aspect), (c) near the tip.
13. *J. juncea* var. b. Cross-sections at the three levels given in fig. 12 to show the internal structure.
14. Spicules of *J. juncea*.
- 15, 16, and 17. Three colonies of *Juncella gemmacca*, reduced proportionately, to show the difference in the branching at different ages.
18. Three portions of *Juncella gemmacca* enlarged ( $\times 5$ ) to show the nature and distribution of the verrucae at different levels, (a) near the base, (b) midway (non-polyp-bearing aspect), (c) near the tip.
19. Transverse sections of *J. gemmacca*, at levels corresponding to those in fig. 18, to show the structure of the coenenchyma ( $\times 5$ ).
20. *Juncella racemosa*. Portion of colony described in XLI.
21. *Juncella racemosa*. Colony enlarged ( $\times 1\frac{1}{2}$ ).
22. Twig of *Juncella racemosa* to show disposition and nature of the verrucae.
23. Spicules of *Juncella racemosa*.
24. Terminal twig of *Juncella trilincata* to show the nature and disposition of the verrucae.
25. Transverse section of *Juncella trilincata* to show (1) the structure of the coenenchyma, (2) the three large main canals, and (3) the position of three alternating rows of verrucae.
26. Spicules of *Juncella trilincata*.
27. Spicules of *Scirpearia profunda*.
28. *Scirpearia hicksoni* n. sp. Portion near the base enlarged ( $\times 4$ ) to show the appearance of the aspect devoid of polyps.
29. *Scirpearia hicksoni* n. sp. Portion near the base enlarged ( $\times 4$ ) to show the nature of the verrucae on the "crowded" aspect.
30. *Scirpearia hicksoni* n. sp. Tip of colony enlarged ( $\times 4$ ) to show the distribution and nature of the verrucae.
31. Spicules of *Scirpearia hicksoni* n. sp.
32. *Scirpearia verrucosa* n. sp. Portion enlarged ( $\times 6$ ) to show the nature and distribution of the verrucae.
33. Spicules of the *Scirpearia verrucosa* n. sp.

Fig.

34. *Scirpearia anomala* n. sp. Three portions enlarged ( $\times 5$ ) to show the difference in the nature and distribution of the polyps at different levels, (a) near base, (b) midway, (c) tip.
35. Spicules of *Scirpearia anomala* n. sp.
- 36-38. Silhouettes of the axis of colonies of *S. pectinata* to show different angles of origin for the branches.
39. *S. pectinata*. Silhouette of axis of a colony to show the crossing of the branches due to contraction.
40. *S. pectinata*. Silhouette of axis of a colony to show how a secondary branch may take the place of a primary.
41. Secondary development in *S. pectinata*.
42. Portion near the base of a colony of *S. pectinata* to show the distribution of the verrucae and the large canals superficially.
43. a, b, and c. Transverse sections of *S. pectinata* to show the structure of the coenenchyma and the disposition of the main longitudinal canals, (a) main stem with numerous large canals, (b) and (c) secondary branch, at different levels, with only two main canals.
44. a and b. Two views from the non-polyp-bearing aspect of a secondary branch of *S. pectinata* to show the disposition of the polyps and also their appearance when partially expanded, (a) about midway, (b) tip.
45. Spicules of *S. pectinata*.
46. Colony of *Scirpearia elongata* in the Museum of the Royal College of Surgeons, London (from a photograph supplied by Dr. Burne).
47. Spicules of the Royal College of Surgeons specimen of *Scirpearia elongata*.
48. Spicules of the British Museum specimen of *Scirpearia elongata*.
49. *Scirpearia flagellum*. Portion of Naples specimen enlarged ( $\times 6$ ) to show the nature and distribution of the verrucae.
50. Spicules of *Scirpearia flagellum* (Naples specimen).
51. Colony (nat. size) of *Scirpearia flagellum* (Cape).
52. Portion of colony (fig. 51) to show the nature of the verrucae.
53. Longitudinal section through the portion of *Scirpearia flagellum* shown in fig. 52 to show the internal structure and the attachment of the strong retractor muscles.
54. Spicules of *Scirpearia flagellum* (fig. 51 specimen).

Fig.

55. Young colony of *Scirpearia flagellum* (nat. size) (Cape).
56. Portion of colony (fig. 55) enlarged ( $\times 12$ ) to show the nature and distribution of the polyps.
57. Spicules of *Scirpearia flagellum* (fig. 55).
58. Portion of a Monaco specimen to show the distribution of the verrucae ( $\times 4$ ).
59. Same as 58)
60. Same as 58) } different specimens.
61. *Scirpearia thomsoni* n. sp. Silhouette of axis to show the nature of the branching.
62. *Scirpearia thomsoni* n. sp. Portion enlarged ( $\times 6$ ) to show the disposition and nature of the verrucae.
63. Spicules of *Scirpearia thomsoni* n. sp.
64. *Scirpearia alba*. Two portions enlarged ( $\times 5$ ) to show the nature and distribution of the verrucae at different levels, (a) near tip, (b) near the base.
65. Spicules of *Scirpearia alba*.
66. *Scirpearia aurantiaca*. Portion enlarged ( $\times 5$ ) near the middle of the colony to show the nature of the verrucae.
67. *Scirpearia aurantiaca*. Portion enlarged ( $\times 5$ ) near the tip of the colony to show the nature of the verrucae.
68. Spicules of *Scirpearia aurantiaca*.
69. *Scirpearia furcata*. Two views of the same portion of the type specimen of *Scirpearia* sp. (?) enlarged ( $\times 5$ ) to show the nature and distribution of the verrucae.
70. *Scirpearia furcata*. Part of type specimen of *Scirpearella* sp. B.
71. *Scirpearia furcata*. Part of type specimen of *Juncella elongata* (Hickson).
72. *Scirpearia furcata*. Spicules of type specimen of *Juncella elongata* (Hickson).
73. *Scirpearia furcata*. Two views of the same part of a colony from the Indian Collection ( $\times 5$ ) to show the nature and distribution of the verrucae.
74. Polyp of *Scirpearia furcata*.
75. Spicules of Indian Collection specimen of *Scirpearia furcata*.

Fig.

76. Silhouette of axis of "Providence" specimen of *Scirpearia furcata* ( $\frac{2}{3}$  n. s.).
77. *Scirpearia furcata*. Small portion of main stem of "Providence" specimen to show the verrucae.
78. *Scirpearia furcata*. Two views near the base of the second primary branch of the "Providence" specimen.
79. *Scirpearia furcata*. Two views midway on the third primary branch of the "Providence" specimen.
80. *Scirpearia furcata*. Two views near the tip of the third primary branch of the "Providence" specimen.
81. Spicules of the "Providence" specimen of *Scirpearia furcata*.
82. *Scirpearia furcata*. Complete colony (nat. size) of a young specimen in the Cape Collection.
83. *Scirpearia furcata*. Portion enlarged ( $\times 8$ ) of a Cape specimen to show the low nature of the verrucae.
84. *Scirpearia furcata*. Portion enlarged ( $\times 4$ ) of a Cape specimen to show the nature of the verrucae.
85. *Scirpearia furcata*. Portion enlarged ( $\times 5$ ) of a Cape specimen to show the nature of the verrucae.
86. *Scirpearia furcata*. Portion enlarged ( $\times 5$ ) of a Cape specimen to show the distribution and nature of the verrucae.
87. Spicules of a Cape specimen of *Scirpearia furcata*.
88. *Scirpearia furcata*. Two views of a portion near the middle of a colony in the Indian Collection to show the distribution of the verrucae, (a) polyp-bearing aspect, (b) non-polyp-bearing aspect.
89. Spicules of Indian Collection specimen (Fig. 88) of *Scirpearia furcata*.
90. Three views from a specimen of *Scirpearia furcata* in the Indian Collection to show the distribution and nature of the verrucae at different levels, (a) near base, (b) midway, (c) tip.
91. Spicules of *Scirpearia furcata*. (Specimen fig. 90.)
92. *Scirpearia furcata*, var. *robusta*. Colony (nat. size) to show the general habit and the distribution of the verrucae.
93. *Scirpearia furcata*, var. *robusta*. Portion enlarged ( $\times 5$ ) near the base to show the nature of the verrucae.
94. Spicules of *Scirpearia furcata*, var. *robusta*. (Andamans specimen.)

Fig.

95. *Scirpearia furcata*, var. *robusta*. Three portions enlarged ( $\times 5$ ) to show the proportions of the different parts and also the nature and distribution of the verrucae, (*a*) near base, (*b*) midway, (*c*) near tip.
96. Spicules of *Scirpearia furcata*, var. *robusta*. (Mergui specimen.)
97. *Scirpearia andamanensis*, n. sp. Colony (nat. size) to show the mode of branching and the general habit.
98. *Scirpearia andamanensis*, n. s. Portion near the tip of a branch enlarged ( $\times 6$ ) to show the nature of the verrucae when slightly retracted.
99. *Scirpearia andamanensis*, n. sp. Portion of a branch enlarged ( $\times 6$ ) to show the nature of the verrucae when partially retracted.
100. *Scirpearia andamanensis*, n. sp. Portion near the base enlarged ( $\times 6$ ) to show the nature of the fully retracted verrucae.
101. Spicules of *Scirpearia andamanensis*, n. sp.
102. *Scirpearia ramosa*, n. sp. Colony (nat. size) to show the mode of branching and the general habit.
103. *Scirpearia ramosa*, n. sp. Portion enlarged ( $\times 6$ ) to show the nature of the verrucae.
104. Spicules of *Scirpearia ramosa*, n. sp.
105. *Scirpearia ceylonensis*, n. sp. Colony one-half nat. size to show the mode of branching and the general habit.
106. *Scirpearia ceylonensis*, n. sp. Portion enlarged ( $\times 5$ ) to show the disposition and nature of the verrucae.
107. Spicules of *Scirpearia ceylonensis*, n. sp.
108. "Challenger" specimen of *Scirpearia maculata* from Banda. (From a photograph supplied by Prof. Bell.)
109. Spicules of the "Challenger" specimen of *Scirpearia maculata*.
110. Fragment of *Juncella gemmacea*, originally described as *Ellisella maculata*.
111. Transverse section through *Scirpearia quadrilincata*, n. sp., to show the structure of the coenenchyma and the position of the four main canals.
112. Two portions of *Scirpearia quadrilincata*, n. sp., slightly enlarged ( $\times 1\frac{1}{2}$ ) to show the distribution and nature of the verrucae at different levels, (*a*) near the tip, (*b*) near the base.

113. Spicules of *Scirpcaria quadrilineata*, n. sp.
114. Spicules of *Nicella dichotoma*.
115. Spicules of *Nicella flabellata*.
116. Spicules of *Nicella reticulata*.
117. Three portions of *Nicella moniliforme*, enlarged ( $\times 5$ ) to show the difference in the distribution and nature of the verrucae at the various levels, (*a*) near the base, (*b*) middle of the colony, (*c*) near the tip.
118. Spicules of *Nicella moniliforme*.



Fig. 1.



Fig. 2.



Fig. 3.

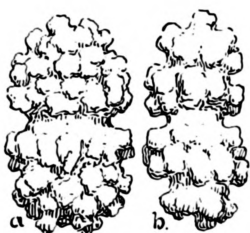


Fig. 5.

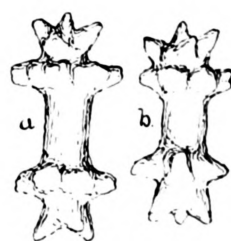


Fig. 7.

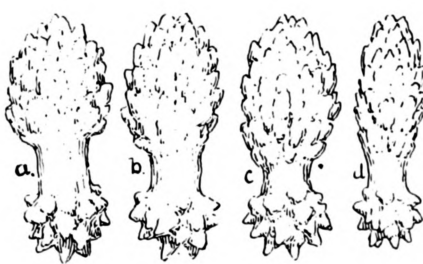


Fig. 4.

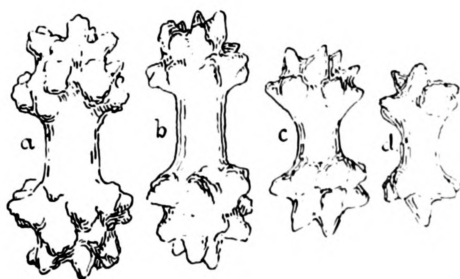


Fig. 6.



Fig. 8.



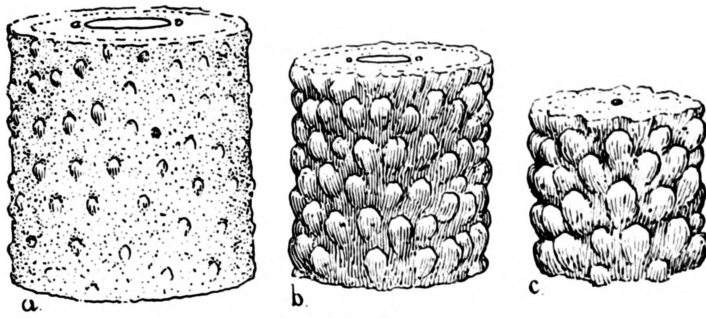


Fig. 9.

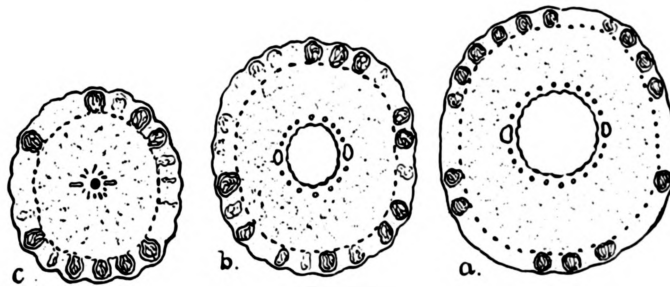


Fig. 10.

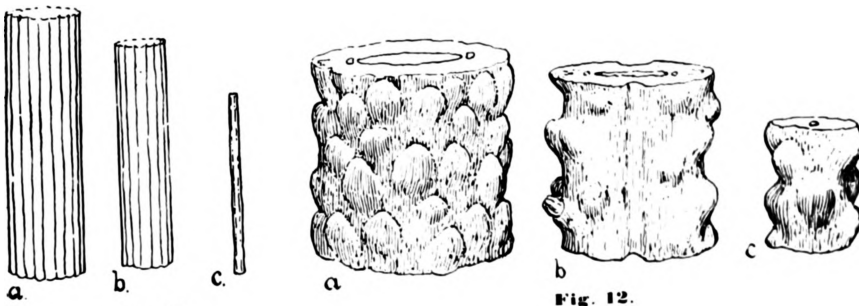


Fig. 11.

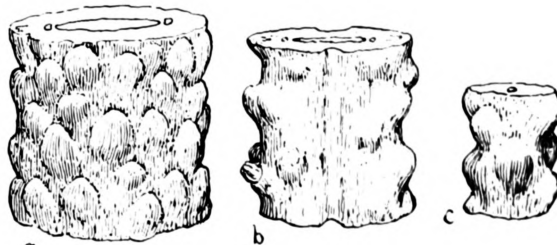


Fig. 12.

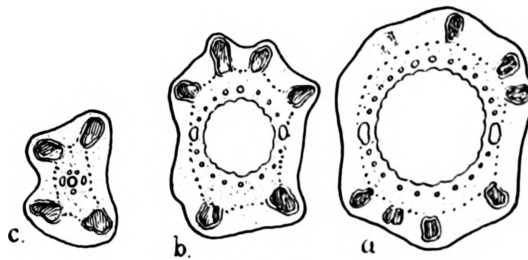


Fig. 13.



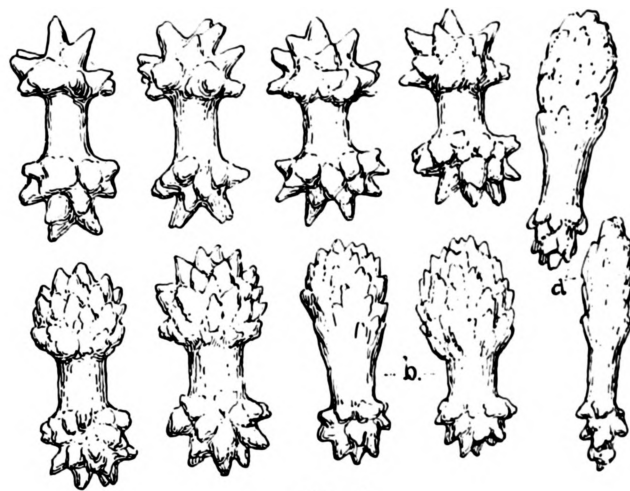


Fig. 14.



Fig. 15.

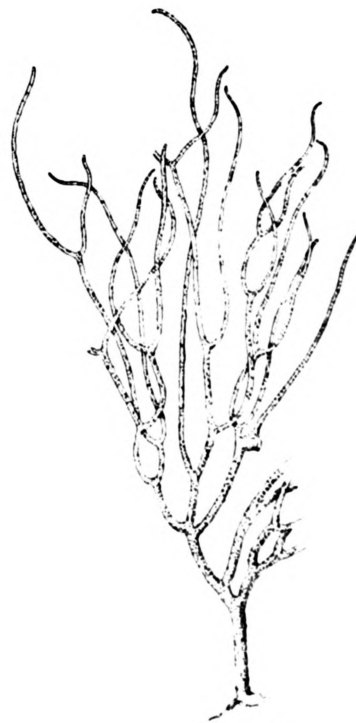


Fig. 16.

SIMPSON — Gorgonellidae.



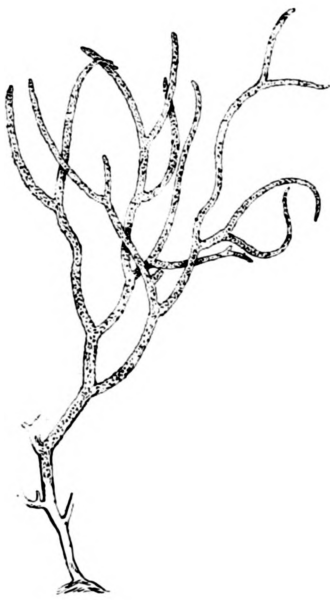


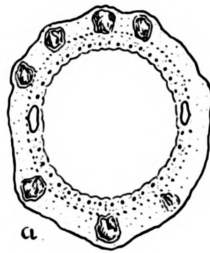
Fig. 17.



c.



b.

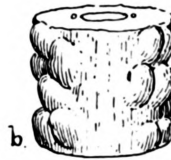


a.

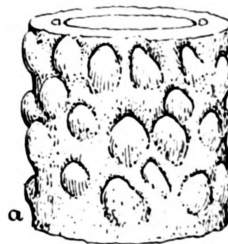
Fig. 19.



c.



b.



a.

Fig. 18.



Fig. 20.



Fig. 21.





Fig. 22.

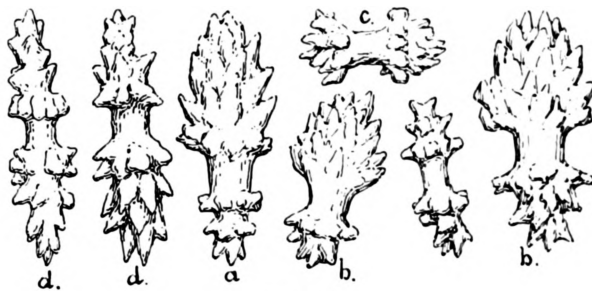


Fig. 23.



Fig. 25.



Fig. 26.



Fig. 24.

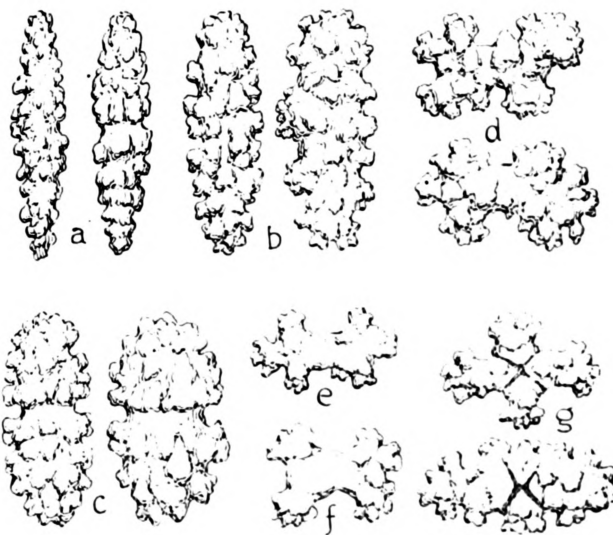


Fig. 27.



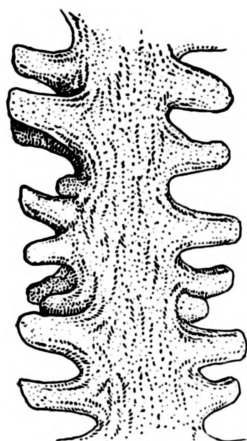


Fig. 28.

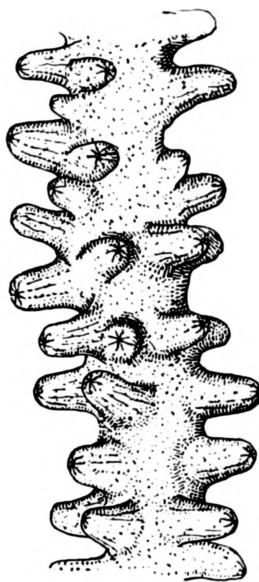


Fig. 29.

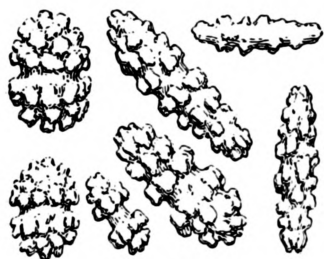


Fig. 31.

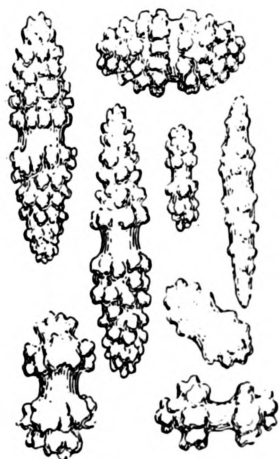


Fig. 33.



Fig. 30.



Fig. 32.



c



b



a

Fig. 31.



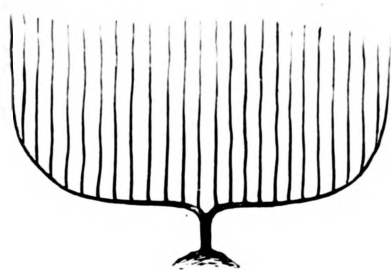


Fig. 36.

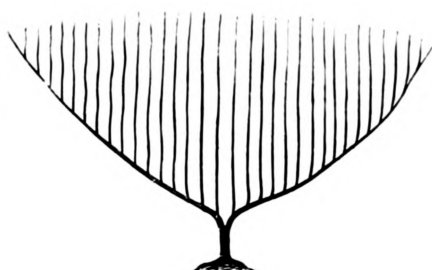


Fig. 37.



Fig. 35

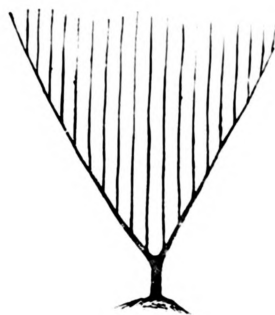


Fig. 38

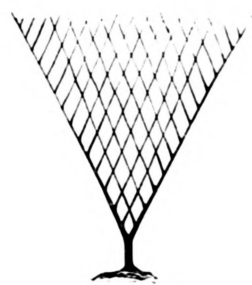


Fig. 39

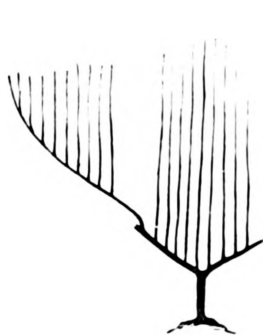


Fig. 40



Fig. 41



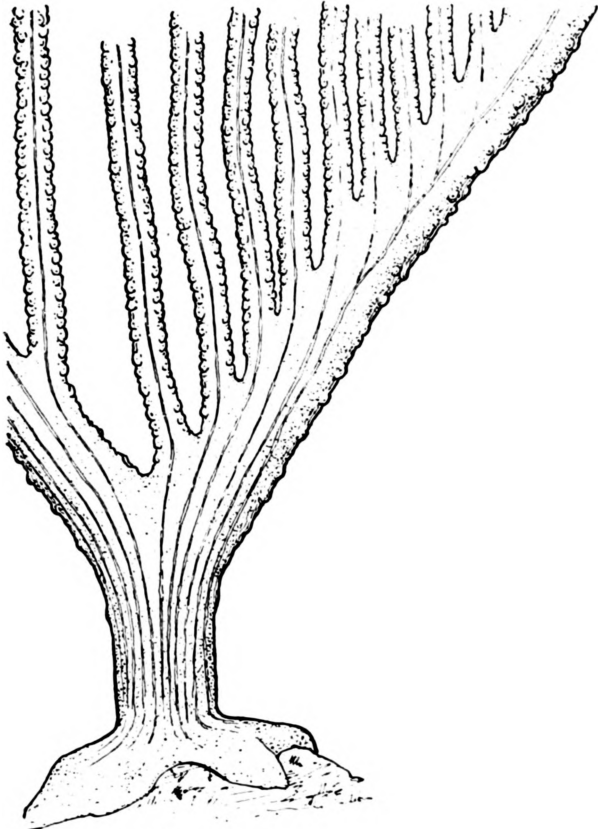


Fig. 12



Fig. 11

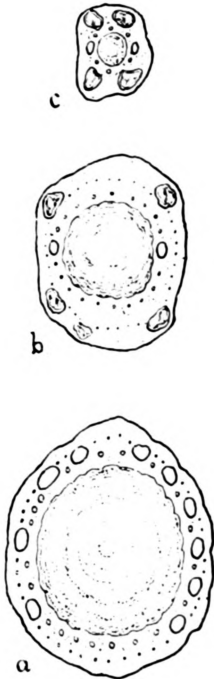


Fig. 13



Fig. 45



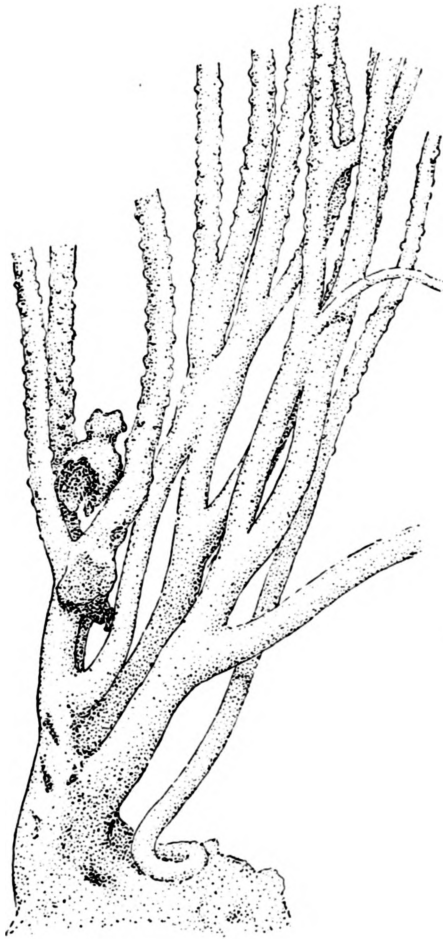


Fig. 46

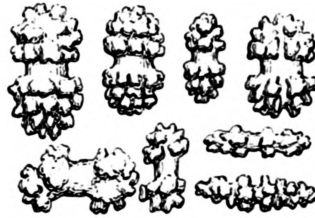


Fig. 47.



Fig. 48



Fig. 49



Fig. 50



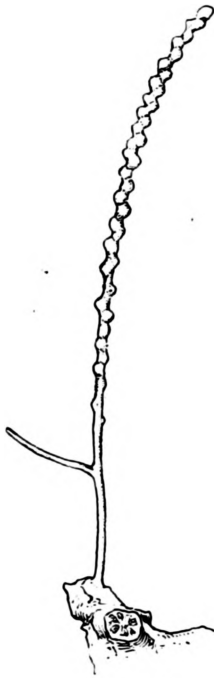


Fig. 51



Fig. 52



Fig. 53



Fig. 55



Fig. 56

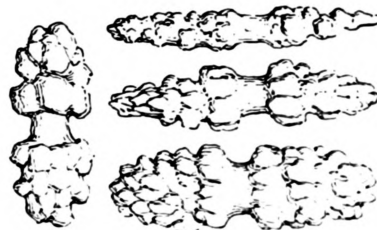


Fig. 51



Fig. 57





Fig. 58

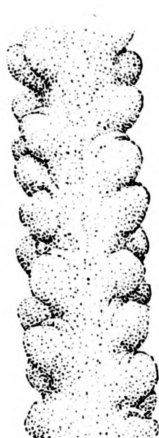


Fig. 59



Fig. 60



Fig. 61



Fig. 62

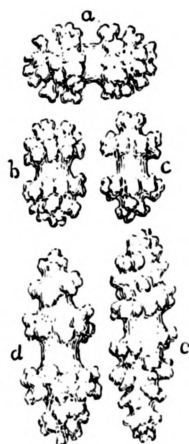


Fig. 63



Fig. 65



Fig. 67



Fig. 66



Fig. 64.



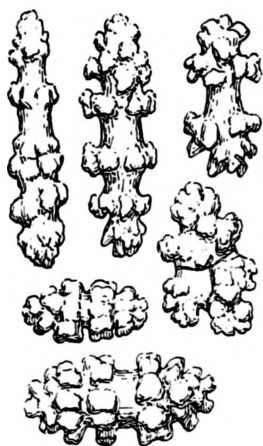


Fig. 68



Fig. 69



Fig. 70



Fig. 71

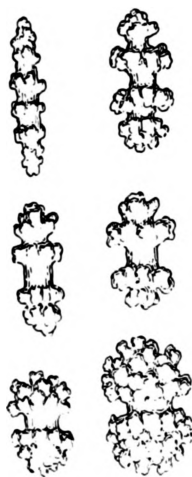


Fig. 72



Fig. 73



Fig. 74

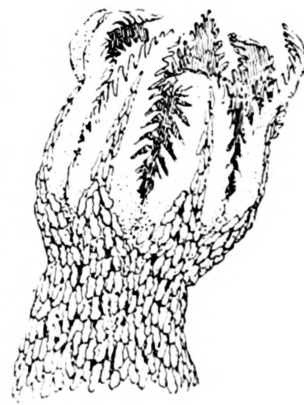


Fig. 76

SIMPSON Gorgonellidae.



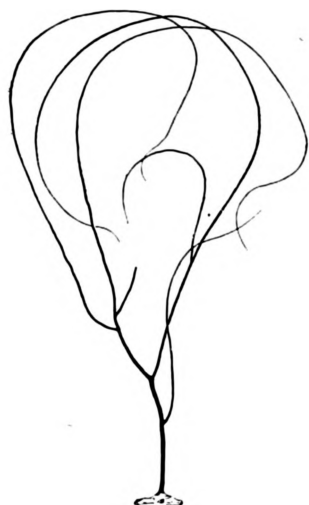


Fig. 76



Fig. 77



(a)



(b)

Fig. 78



(a)



(b)

Fig. 80



(a)



(b)

Fig. 79



Fig. 83



Fig. 81



Fig. 82



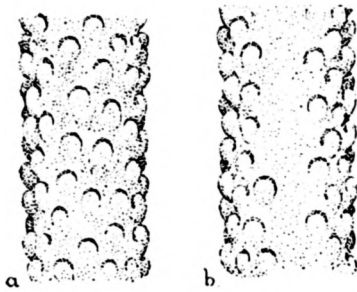


Fig. 84

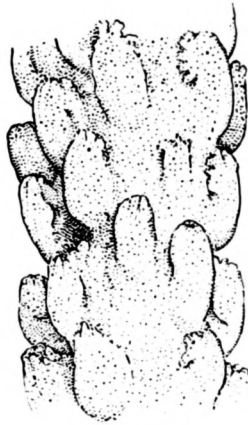


Fig. 85



c

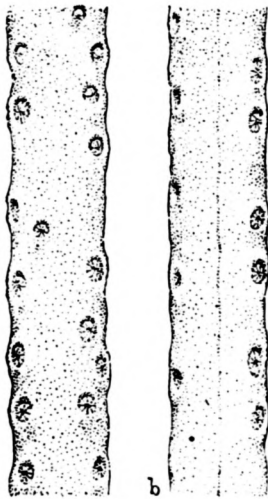


Fig. 88

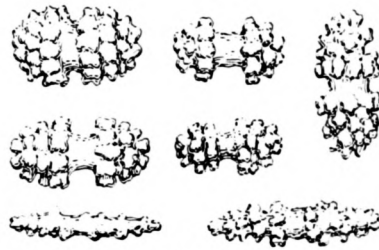


Fig. 89



Fig. 90

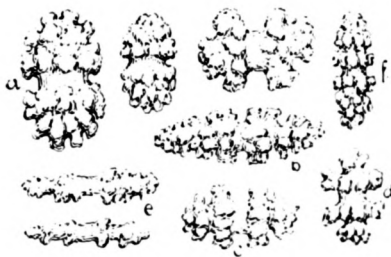


Fig. 91



Fig. 92



b



a

Fig. 94



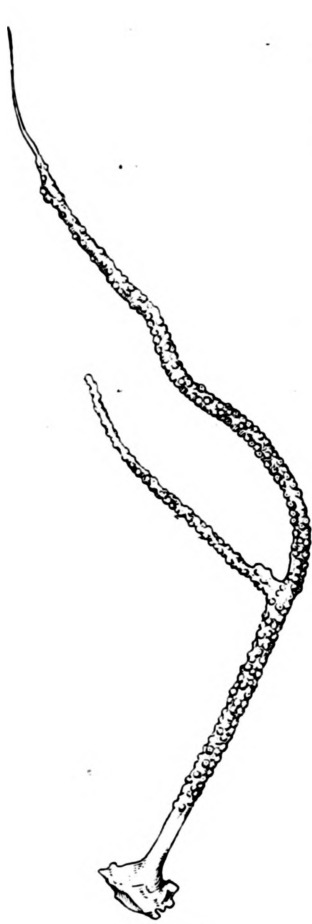


Fig. 92

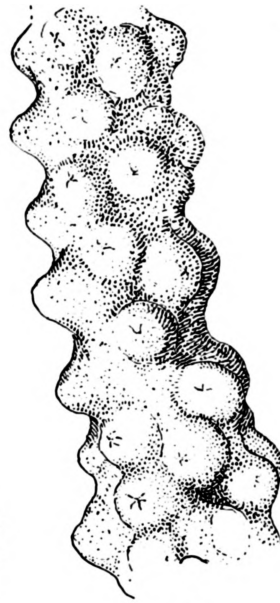


Fig. 93



Fig. 94



Fig. 96

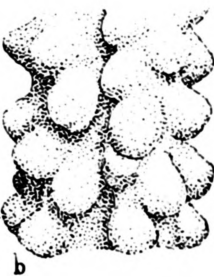
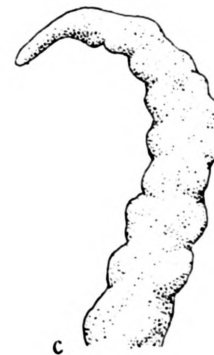


Fig. 95

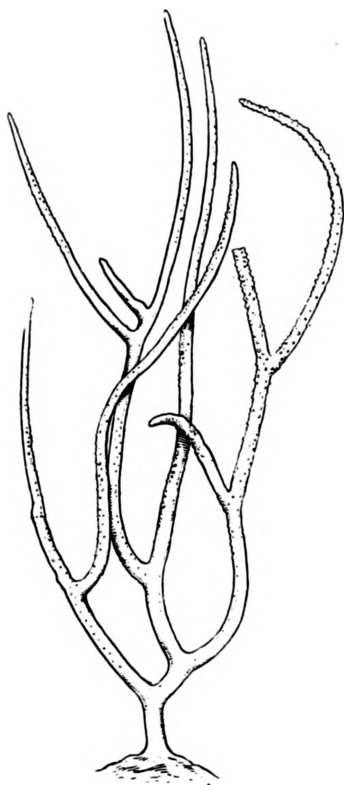


Fig. 91

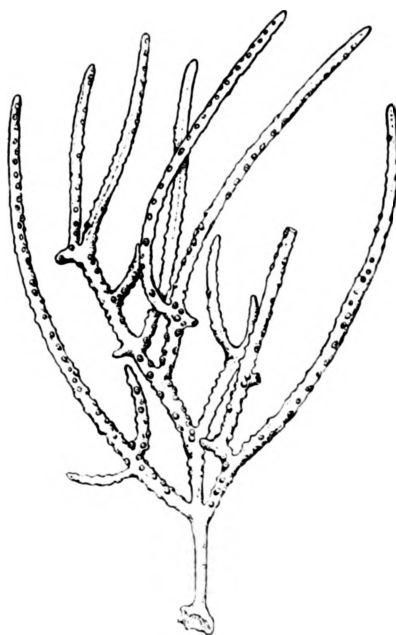


Fig. 90





**Fig. 97**



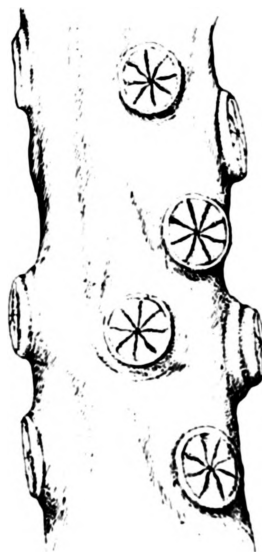
**Fig. 102**



**Fig. 100**



**Fig. 101**



**Fig. 103**





**Fig. 104**



**Fig. 106**



**Fig. 107**



**Fig. 109**



**Fig. 108**



**Fig. 105**



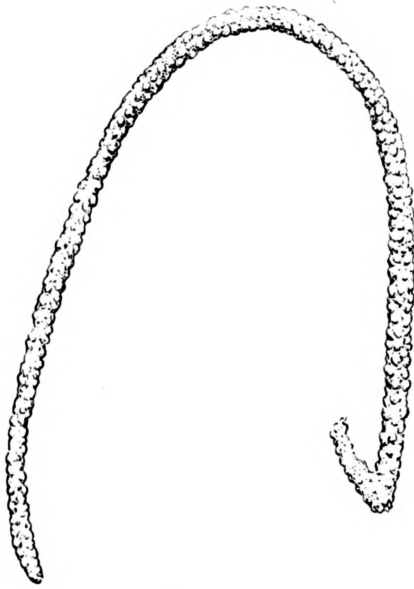


Fig. 110



a.



b.

Fig. 112



Fig. 111



Fig. 114



Fig. 115



Fig. 113



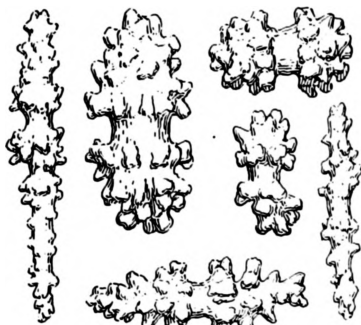


Fig. 116

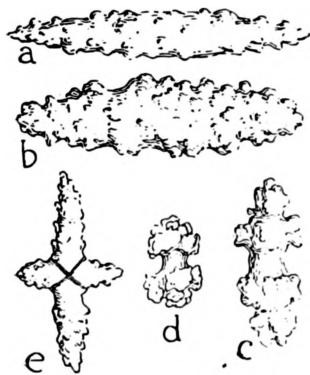


Fig. 118



Fig. 117



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THE  
ALCYONARIANS OF THE "THETIS"  
EXPEDITION.

By PROFESSOR J. ARTHUR THOMSON, M.A.,

AND

MISS DORIS L. MACKINNON, B.Sc.

*Carnegie Scholar, University of Aberdeen.*

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## ALCYONARIA.

By J. ARTHUR THOMSON AND DORIS L. MACKINNON.

(Plates lxi-lxxxii.)

The collection of Alcyonarians made by the "Thetis" includes thirty-five species, of which thirteen are new,—a large proportion. When the specimens are arranged in systematic order, it is seen at a glance that the collection has a very definite character, namely, the proportionately large number of Isidæ (e.g., six species of *Mopsea*, four new) and of Primnoidæ (e.g., five new species of *Plumarella*). These Isid and Primnoid colonies are extraordinarily beautiful, and their superficial resemblance to large fronds of Sertularians is striking. It is a matter for gratification that numerous specimens of some of the new species have been preserved, so that it was possible to make sure that one was not dealing with *individual* variations.

Another feature of the collection is the frequent occurrence of encrusting colonies of *Alcyonium* (*Erythropodium*) *membranaceum* and *A. reptans* described by Kükenthal, which grow over Gorgonid axes in a very misleading fashion. It is not too much to say that an unprejudiced observer, who had not seen the real state of affairs exposed in unmistakeable cases, would describe these Gorgonid axes encrusted with *Erythropodium* as peculiar Axifera.

### LIST OF SPECIES <sup>1</sup>.

#### Order I. STOLONIFERA, *Hickson*.

##### Family CORNULARIIDÆ.

*Clavularia flava*, Hickson.

#### Order II. ALCYONACEA, *Verrill* (pro. parte).

##### Family ALCYONIDÆ.

*Alcyonium* (*Erythropodium*) *membranaceum*, Kükenthal.

*reptans*, Kükenthal.

\* " *etheridgei*", sp. nov.

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<sup>1</sup> Those that are new are marked with an asterisk.

## Family NEPHTHYIDÆ.

- Lithophytum flabellum* (Q.G.).  
 \* *Dendronephthya waitei*, sp. nov.

## Order III. PSEUDAXONIA, G. von Koch.

## Family MELITODIDÆ.

- Mopsella clavigera*, Ridley.  
 " *textiformis* (Lamarck).  
*Psilacabaria gracillima*, Ridley.  
*Parisis australis*, Wright and Studer

## Order IV. AXIFERA, G. von Koch.

## Family ISIDÆ.

- Mopsea dichotoma* (Linné).  
 " *encrinura* (Lamarck).  
 \* " *australis*, sp. nov.  
 \* " *flabellum*, sp. nov.  
 \* " *elegans*, sp. nov.  
 \* " *whiteleggei*, sp. nov.  
*Acanthoisis flabellum*, Wright and Studer.

## Family PRIMNOIDÆ.

- Stachyodes studeri*, Versluys (*S. regularis*, Wright and Studer).  
 \* *Amphilaphis plumacea*, sp. nov.  
 \* *Flumarilla laevis*, sp. nov.  
 \* " *thetis*, sp. nov.  
 \* " *corruscans*, sp. nov.  
 \* " *filicoides*, sp. nov.  
 \* " *versluysi*, sp. nov.  
*Primnoella australasia*, Gray.  
 " *flagellum*, Studer.  
 " *distanis*, Studer.  
 \* *Caligorgia laevis*, sp. nov.

## Family GORGONIDÆ.

- Leptogorgia*, sp. (?)

## Family GORGONELLIDÆ

- Ctenocella pectinata* (Pallas).

Order V. STELECHOTOKEA, Bourne.

Section ASIPHONACEA.

Family TELESTIDÆ.

- Telesto trichostemma* (Dana).  
 „ *arhorea*, Wright and Studer.

Section PENNATULACEA.

Family KOPHOBELEMNONIDÆ.

- Kophobelemnion schmeltzii* (Kölliker), = *Sclerobelemon schmeltzii*,  
 Kölliker.

Family PTEROEIDIDÆ

- Godeffroyia elegans*, Kölliker.  
*Sarcophyllum australe*, Kölliker.

Of the thirty-five species in the collection, the following thirteen have been previously recorded from Australian seas:—

- Clavularia flava*, Hickson.  
*Mopsella clavigera*, Ridley.  
 „ *textiformis* (Lamarck).  
*Psilacabaria gracillima*, Ridley.  
*Parisis australis*, Wright and Studer.  
*Mopsea dichotoma* (Linné).  
 „ *encrinura* (Lamarck).  
*Acanthoisis flabellum*, Wright and Studer.  
*Primnoella flagellum*, Studer.  
*Primnoella australasiae*, Gray.  
*Ctenocella pectinata*, Pallas.  
*Telesto trichostemma* (Dana).  
*Sarcophyllum australe*, Kölliker.

The most striking of the records of distribution are the following:—*Primnoella flagellum*, Studer, previously reported by Hickson from Australian seas, was originally found in the South Atlantic, off Patagonia; *Primnoella distans*, Studer, was previously found off the West Indies and Brazil; *Kophobelemnion schmeltzii* (Kölliker), was previously found off Formosa; *Godeffroyia elegans*, Kölliker, was previously recorded from the Gulf of Siam.

Order I. STOLONIFERA, *Hickson*.

## Family CORNULARIIDÆ.

Genus CLAVULARIA, *Quoy and Gaimard*.CLAVULARIA FLAVA, *Hickson*.

*Clavularia flava*, Hickson.—A Revision of the Genera of the Alcyonaria Stolonifera with a Description of one New Genus and several New Species. (Trans. Zool. Soc., xiii, 1894, p. 341, pl. 1., figs. 12 and 13).

*Clavularia flava*, Hickson.—Preliminary Report on a Collection of Alcyonaria and Zoantharia from Port Philip. (Proc. Roy. Soc. Vict., (n.s.), ii., 1890, pp. 136-140).

A few small pieces of a *Clavularia* agree with Hickson's description of *C. flava*. The stolons are thin and ribbon-like; the cylindrical polyps, 3.5 mm. in height, with a diameter of about 1.5 mm., are separated from one another by rather wide intervals, 1.2-5 mm. The upper part of the polyp with the tentacles is retracted completely into the stout-walled, heavily-armoured lower portion. The spicules agree with those described by Hickson, but are flesh-pink instead of yellow. The colour of the colony is a deep salmon-pink.

Kükenthal<sup>2</sup> places *Clavularia flava*, Hickson in his amended genus *Anthelia*. His amended genus *Clavularia*, however, is separated from *Anthelia* by having a lower, non-retractile, calyx-like thick-walled portion, and an upper, retractile, thin-walled portion bearing the tentacles. As *Clavularia flava*, Hickson, answers this description, we think that Kükenthal is mistaken in seeking to remove it from its original position in the genus *Clavularia*.

*Locality*.—Between Port Jackson and Tuggerah.

Previously recorded from the coast of Victoria, shallow water.

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<sup>2</sup>Kükenthal—Alcyonacea—Wissenschaftliche Ergebnisse der Deutschen Tiefsee Expedition, xiii., 1906, p. 11.

Order II. ALCYONACEA, *Verrill* (pro parte).

## Family ALCYONIDAE.

Genus ALCYONIUM, *Linne*.ALCYONIUM (ERYTHROPODIUM) MEMBRANACEUM,  
*Kükenthal*.

*Alcyonium membranaceum*, Kükenthal, Alcyonacea—Wiss. Ergeb. deutsch. Tiefsee Exped., xiii, 1, 1906, pp. 52-53, pl. 1, fig. 3, pl. ix, figs. 42-44.

Stations 42, 44, 34, 43, 47, 48.

Numerous Gorgonid axes, e.g. of *Ctenocella*, are almost covered by *Symphodium*-like growths, which investigation shows to be creeping Alcyonids, agreeing on the whole, with Kükenthal's description of *Alcyonium* (*Erythropodium*) *membranaceum*. The cœnenchyma-spicules are very variable in form. There are approximately spherical bodies (diameter .08-.12 mm.), short thick cylinders with about two bands of thorny warts, forms like cervical vertebrae, and others of more irregular shape. The polyp spicules are spindles. Below the eight points of converging spicules in the anthocodia there is a deep collaret of about eight rows of horizontally disposed slender spindles. The colour of the colonies is light brown.

This species presents considerable difficulties to the classifier. In some specimens the Gorgonid axis is so completely and so evenly overgrown with the Alcyonid, that it is hard to believe that one is not dealing with the natural cœnenchyma. There is, however, a slight tendency to the formation of "independent stocks," and at the tips of the branches the encrustation often forms a well-marked projection beyond the axis. On the more weathered specimens it is instructive to note how the encrusting Alcyonid is brought up sharply against large groups of Cirripedes, Sponges, etc., which have also found the Gorgonid axis a suitable place of attachment.

In the majority of our specimens the internal structure could not be made out with certainty, owing to their being in the dried condition, and extremely friable. In the spirit-specimens, however, the cœnenchyma shows the Alcyonid arrangement of side-canals between the gastral cavities of the polyps, an arrangement that, in Kükenthal's opinion, removes these *Symphodium*-like

forms into the genus *Alcyonium*, where the sub-genus *Erythropodium* is designed for those that grow as membranous expansions.

*Locality*.—Eleven miles east of Broken Bay.

Previously recorded from 34°7'3" S. Lat., 24°59'3" E. Long., Francis Bay, 100 metres.

#### ALCYONIUM (ERYTHROPODIUM) REPTANS, *Kükenthal*.

(Pl. lxi., fig. i.)

*Alcyonium reptans*, Kükenthal, Alcyonacea—Wiss. Ergeb. deutsch. Tiefsee Exped., xiii., 1, 1906, pp. 53-54, pl. ii., fig. 9, pl. ix., figs. 45-49.

Stations 17, 34, 41, 42, 43, 44, 48, 53.

For 57 cm. of its entire length (83 cm.) the axis of a specimen of *Primnoella australasiae* is completely overgrown with a light chocolate-coloured, *Sympodium*-like Alcyonid, which agrees with Kükenthal's description of *Alcyonium (Erythropodium) reptans*. The same species covers a branched Gorgonid axis from which all trace of the original cœnenchyma has disappeared. Numerous smaller specimens also occur that show scarcely more than a fibrous residue of the Gorgonid axis which the *Sympodium*-like mass had originally made its support. Without the more complete specimens with which to make a comparison, these last forms would be very difficult of interpretation.

The spicules in every case are (1) slender spindles with few and simple warts, .306 x .084 mm.; .27 x .032 mm.; .204 x .017 mm.; (2) stouter, blunter spindles with more numerous, projecting tuberculate warts—.255 x .068 mm.; .238 x .052 mm.; (3) flattened spindles with jagged and toothed margins—.323 x .051.; .289 x .034 mm.; (4) a few irregular bodies—.085 x .051 mm.

*Locality*.—Eleven miles E. by N. of Barrenjoey, 30-40 fathoms, rocks.

Previously recorded from the east side of Bouvet Island, 470 metres.

#### ALCYONIUM ETHERIDGEI, *sp. nov.*

(Pl. lxi., fig. 2 and 3; pl. lxii., fig. 3; pl. lxvii., fig. 4; pl. lxix.)

Stations 10, 17, 28, 31, 34, 41, 44.

This striking form is represented by numerous specimens. The largest colonies have the following dimensions.—Height and breadth in centimetres 7.5 x 8, 8.5 x 8.5., and 9.5 x 7., the smallest is .5 cm. high by .7 cm. broad.

Nearly all the specimens are complete. From a slightly encrusting base rises a stout stalk portion, with a diameter, in the largest specimen, of 4.5 cm. This stalk is of very firm consistency, and has a rather harsh, wrinkled surface. The polyparium of the smallest specimen is unbranched and club-shaped. In all the others at a height of 2.3 cm. the stalk-portion divides up into a number of stout, diverging, finger-like lobes, 1.2 cm. in diameter. These subdivide into secondary lobes, usually from 0.5-1.75 cm. in height, with diameters ranging from 1 cm. to 1.75 cm. Upwards from a point about .5-2 cm. from the base, the entire colony is covered with polyps which, in most of the specimens, are retracted into low, rounded, eight-lobed calyces. The average distance between two polyps is 1.5 mm. The polyps, when fully expanded, have a length of 3.5 mm. They are marked with eight longitudinal grooves, and just below the level of the tentacles they are armoured with eight isosceles triangles, each composed of 8-10 converging pairs of slender spicules. Near the base of each triangle these meet at an angle of about 45°; higher up, they are almost parallel; but very occasionally one or two are directed horizontally below the triangular points. The tentacles are entirely without spicules: they are long and feathery, with about ten long pinnules on each side of the middle line in a single row.

The whole surface of ctenenchyma appears as though dusted over with a thick sprinkling of small, white, glistening spicules, which bear a resemblance to grains of sugar. These are stout double-clubs and capstan-like bodies with a distinct "neck," and, on an average, two whorls of projecting, tuberculate warts. The following measurements were taken of length and breadth in millimetres:—1.87 x .119; .17 x .119; .119 x .102; .085 x .085. Smaller forms (.102 x .068 mm.; .085 x .051 mm.) approach Kölliker's "Sechser" and are probably young stages of the first. The entire cortex is crowded with spicules of the same form as those on the surface, and similar spicules occur, but much more sparingly in the canal walls.

The spicules of the polyps are spindles and clubs of slender form, with a few projecting warts. Their dimensions in mm. are .306 x .034; .27 x .068; .204 x .017; .17 x .017.

The colour of the colonies is greyish-brown to dark-brown; the polyps are a darker shade of the same colour.

In many respects this species comes very near to Hickson's *Alcyonium purpureum*<sup>3</sup>.

<sup>3</sup>Hickson—The Alcyonaria of the Cape of Good Hope, part ii.—Marine Investigations in South Africa, iii., 1904, pp. 215-217, pl. vii., fig. 1, pl. ix., fig. 18.

Our species differs from Hickson's in the absence of the characteristic purple colour, the presence of a distinct stalk-portion, the sparser distribution of the polyps, the larger size of the polyp spicules, and the simpler character of the coenenchyma spicules, the double-clubs in *Aleyonium purpureum* being figured with at least four whorls of warts. The powdered appearance of the surface of the coenenchyma in our specimens is exceedingly characteristic.

*Locality*.—Manning Bight, 22 fathoms.

### Family NEPHTHYIDAE.

Genus LITHOPHYTUM, *Forskal.*

#### LITHOPHYTUM FLABELLUM (Q.G.)

*Lithophytum flabellum*, Kükenthal, Versuch. einer Revision der Alcyonarien, ii. Die Familie der Nephthyiden, i. Theil. Zool. Jahrb., xix., 1903, p. 111.

A single catkin of this species was found among some broken fragments in the present collection.

*Locality*.—Coast of New South Wales.

Previously recorded from Zanzibar, Solomons, Tumbatu, New Ireland, Carteret Harbour, and Egmont.

Genus DENDRONEPHTHYA, *Kükenthal.*

(*Spongodes* in part).

#### DENDRONEPHTHYA WAITEI, *sp. nov.*

(Pl. lxii., fig. 4; Pl. lxx., fig. 2; Pl. lxxii., fig. 3.)

Station 25.

Several compact, bushy colonies, from 5 to 7 cm. in height, represent this interesting species. The specimens are all intact, and show great uniformity in their mode of growth. From a luxuriantly-rooting basal attachment rises a somewhat flaccid stalk, which just above the roots has a diameter of 10 mm., but swells out to 16 mm. higher up. At a height of about 2 cm. the stem is surrounded by foliaceous expansions bearing polyps along their edges. Above this, numerous small branches come off, and the stem finally divides into two main branches, which ramify extensively. The stem tends to be exposed on one side in its upper reaches, as there is a much sparser occurrence of branches on one side than on the other.

Over the branching side of the colony the polyp-bundles form a dense covering. The polyps occur in bundles of about six, in typically "glomerate" arrangement.

The polyp-stalks are very long, 1.5-2.5 mm. The polyp-heads are about 1.5 mm. and make an angle with their stalk that may be either a right angle or obtuse. The Stützbündel is very weakly developed; it consists of about four almost smooth spindles.

In contrast with the long polyp-stalk the Stützbündel seems quite inconspicuous, and this gives a *Stereacanthia*-like appearance to the polyp. The armature of the polyp consists of eight longitudinal rows of closely apposed pairs of curved spindles; there are about six to eight pairs in a row, of which the uppermost pair is the most strongly developed. One or both of this uppermost pair may project slightly above the polyp-head. Between the adjacent "points" thus formed, a few small spindles lie without regular arrangement. Unlike the spicules of the Stützbündel and polyp-stalk, which are yellow-brown smooth spindles with scarcely any warts, the spicules of the polyp-head are colourless, bent spindles, with more numerous, rather prominent warts. The following measurements were taken of length and breadth in millimetres:—(1) spicules of polyp-stalk, 1.37 x .085; .765 x .035; .425 x .017; (2) polyp-spicules, .765 x .051; .544 x .034; .34 x .017; .255 x .025. There is a median row of very small, transversely-disposed spicules along each tentacle.

The spicules of the cortex are, in the upper part of the colony directed more or less transversely. They are long spindles (2.97 x .17 mm.; 1.78 x .19 mm.; 5.27 x .34 mm.) with few, small warts. In the branches these superficial spindles are smaller, and take a longitudinal direction. Below the point where the ring of foliaceous branches comes off, the character of the cortical spiculation changes. There are still a few spindles, but the great majority of the spicules are small opaque, white stars, tri- and quadri-radiates and irregular spiny forms. .204 x .17 mm.; .119 x .102 mm.; .102 x .085 mm.

In the canal-walls of the lower part of the colony a few similar star-like spicules are to be found. In the upper reaches of the canal-walls no trace of spicules could be found.

The colour of the stem is brownish gray with a reddish tinge on the branches; the roots are dark gray, and the polyps and their stalks are red-brown.

In certain features this species approaches very closely *Dendronephthya maxima*, Kükenthal, particularly in the form of the long-stalked polyps with their weakly-developed Stützbündel, and in the remarkable smoothness of the cortical spindles. But our species shows larger polyps, a greater number of spicule pairs in the longitudinal rows on the polyps, and these spicules are not smooth as in *D. maxima*, nor do they show any

tendency to form clubbed ends. Furthermore, the spicules on the tentacles are not arranged in a double row "en chevron." The spindles of the cortex are very much larger than in *D. maxima*; the stars and irregular spiny bodies of the base are similar in both species, but the canal-walls in our specimens do not show any of the numerous, disc-shaped concretions characteristic of *D. maxima*.

### Order III. PSEUDAXONIA, *G. von Koch*.

#### Family MELITODIDAE.

Genus MOPSELLA, *Gray*.

MOPSELLA CLAVIGERA, *Ridley*.

(Plate lxviii., fig. 9.)

Stations 34, 40, 42 and 48.

*Mopsella clavigera*, Ridley, Report Zool. Coll. H.M.S. "Alert," 1884, p. 360, pl. xxxvii., fig. b. pl. xxxvii., figs. a-a<sup>III</sup>.

The largest specimens have lengths of 18 cm., 23.5 cm., 30 cm., and 53 cm. respectively. The branching is generally dichotomous and is strictly in one plane. The branches arise from the nodes, which are very markedly swollen. In the largest specimens they have a diameter of as much as 18 mm. There is no anastomosis.

The polyps are chiefly confined to one surface, over which they are disposed irregularly in slightly projecting verrucae. Into these the polyps are in the most cases retracted. The polyp armature consists of eight triangular points of three or four converging pairs of delicate spindles; below these are about two rows of similar spicules disposed horizontally. A double row of minute spicules, "en chevron," occurs along the middle line of each tentacle.

The spicules of the coenenchyma are exactly like those described by Ridley, *i.e.*—(1) orange-coloured fusiform shapes, rather coarsely tuberculate, swollen, tapering, with occasional "Blattkeulen" at one end— $18 \times .034$  mm.;  $15 \times .035$  mm. (2) "Blattkeulen" of lemon-yellow colour, in shape like small pointed trowels, with a short handle, and a blade formed of about two lancet shaped laminae— $0.76 \times .034$  mm.;  $0.51 \times .032$  mm.;  $0.42 \times .025$ .

With regard to the distribution of the coenenchyma spicules, it may be remarked that the orange-coloured spindles generally

form the lower stratum, over the surface of which the yellow clubs are disposed in a thin layer, which may cover the entire colony, or may be confined to a broad circle round each polyp-opening.

*Locality*.—Eleven miles east of Broken Bay, 30-40 fms.

Previously recorded from Port Curtis, Queensland, 5-11 fms., Port Molle, 14 fms., Thursday Island, Torres Straits, 4-6 fms.; Dirk Hartog Island, West Australia (Studer).

#### MOPSELLA TEXTIFORMIS, *Lamarck*.

(Plate lxiii., figs. 4 and 5.)

*Mopsella textiformis*, Ridley, Report Zool. Coll. H.M.S. "Alert," 1884, pp. 358-360.

The strong basal portion of what must have been a large colony. It is about 23 cm. in height, and the diameter near the base is as much as 3 cm. The length of the inter-nodes varies from 4 to 9 mm., and of the nodes 4-6 mm. The colour of the axis is rose. At the base where it is weathered and the longitudinal canals are exposed, the axis has a very remarkable labyrinthine pattern. The main stem gives off several strong branches in one plane, and these seem to have given off numerous secondary branches strikingly slender in contrast. There has been abundant anastomosis. Most of the ctenenchyma has been worn off, but here and there patches remain of a bright yellow colour. In regard to spicules the specimen agrees well with Ridley's description, but very few of the characteristic dentate "Blattkeulen" have long shafts. In these spicules the shafts are usually orange and the heads lemon yellow. The nodes contain the usual smooth rods.

*Locality*.—Lord Howe Island.

Previously recorded from many Australasian Stations.

#### Genus PSILACABARIA, *Ridley*.

#### PSILACABARIA GRACILLIMA, *Ridley*.

*Psilacabaria gracillima*, Ridley, Rep. Zool. Coll. H.M.S. "Alert," 1884, pp. 364-365, pl. xxxvii., figs. d-d", pl. xxxviii., figs. f-f".

Stations 34, 36, 48

A number of broken pieces seem referable to *Psilacabaria gracillima*, Ridley. The chief characteristics of this species may

be summarised:—dichotomous branching approximately at right angles and in one plane; absence of anastomosis; the axis of the internodes hard, white, not striated; low, rounded, tubercular polyps arranged in a rather irregular manner, in spirals, and opposite; chief forms of spicules.—(1) large cylinders (.28 to .31 x .087 mm.), fusiform to sub-clavate, with thick axis, slightly tapering to round-pointed ends, provided with strong tubercles with tendency to arrangement in whorls; (2) smaller spindles (.21 to .25 x .053 to .071 mm.), more or less curved, with sharp ends and roughened tubercles.

The colour of the specimens is yellowish-brown.

*Locality*.—South Coast of New South Wales.

Previously recorded from Port Molle, Queensland, 12-30 fathoms; Port Darwin, 8-12 fathoms; East Australia, 42 fathoms.

Genus *PARISIS*, Verrill.

*PARISIS AUSTRALIS*, Wright and Studer.

(Plate lxx.)

*Parisis australis*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, pp. 183-184, pl. xli., fig. 5.

Stations 13, 34, 44, 47, 48.

This species was founded on two fragments, much overgrown by an encrusting sponge. In the present collection there are numerous specimens, many of them almost entire, so that we are able to amplify the original description.

The largest colony is 35 cm. high, with a spread of 18 cm. From a slightly encrusting calcareous base arises the cylindrical stem, with an average diameter of 6 mm. which soon begins to give off branches. These arise on the sides, alternately and in one plane.

Higher up all distinction between main stem and branches is lost. The upper part of the colony consists of a close tangle of equal sized branches, 3.3-5 mm. in diameter, which divide dichotomously or give off short branches quite irregularly, but invariably in one plane. The tendency is for all the branches to bend upwards at the tip, and the axillary angle is 45°-60°. Though the branches often overlap one another, or even entwine slightly, there is never any anastomosis.

The surface of all the colonies is more or less encrusted with a siliceous sponge, which often entirely obscures the underlying structure, and produces by its numerous projecting spicules a curious brown, velvety surface. Beneath this is the hard pavement-like surface-layer of the *Parisis*, consisting of cream-white cœnenchyma spicules.

In the lower part of the stem the calcareous and horny joints have approximately equal lengths of about 2.5 mm.; but higher up the internodes greatly predominate, 3.4 mm., while the nodes are reduced to mere constrictions, .5 mm. in length. The internodes are white, and bear somewhat distant longitudinal grooves.

On the younger colonies and smaller branches the arrangement of the polyps is bilateral, but on the larger branches they may occur all round. In one specimen where they were less obscured by sponge-growth than elsewhere, the polyps had a height of .75 mm. with a diameter of 1 mm.; they projected from the branch as low, rounded warts.

The spicules are exactly like those described by Wright and Studer—i.e., massive warty spindles, some almost as broad as long, and approaching spheres. The warts are high and prominent and finely sculptured. The following measurements were taken of length and breadth in millimetres.—.261 x .17; .25 x .1; .2 x .16; .17 x .1.

This species is distinguished from *Parisia fruticosa*, Verrill—(1) by the branches coming off at angles of 45°-60°, instead of at approximately right angles; (2) by the polyps occurring all round the branches instead of being strictly bilateral; (3) by the smaller size, and greater slenderness of the spicules.

*Locality*.—South Coast, New South Wales.

Previously recorded from Station 163 B, off Port Jackson, 35 fathoms.

#### Order IV. AXIFERA, *G. von Koch*.

##### *Family* ISIDAE.

Genus MOPSEA, *Lamouroux*.

MOPSEA DICHOTOMA, *Linne*.

(Plate lxvii. fig. 1.)

*Morpsea dichotoma*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, pp. 41-42, pl. ix., fig. 10.

Stations 48, 47, 53.

The largest specimen is an almost complete lyre-shaped colony, rising from a slightly encrusting calcareous base to a height of 22.5 cm. The main stem, 3 mm. in diameter near the base, divides to form two equal branches at a height of 2.5 cm. These two main branches give rise along one side to a number of

secondary branches which run parallel to one another. As these secondary branches are nearly as thick as the main branch from which they spring, the effect of a repeated dichotomy is produced, an effect that is heightened by the tendency of the main branch to bend outwards after each branch is given off, so that its course describes a series of shallow curves. The secondary branches rise straight upwards and may remain unbranched throughout their length, or may divide dichotomously. Branching is strictly in one plane.

The polyps are arranged in close spirals all over the larger colonies, though one young specimen shows the polyps in a single alternating row on each side of the branch.

The polyps are club-shaped, with truncated mouths; they are directed upwards, and bent towards the stem. In the largest specimen the upper parts of the polyps have all been rubbed off, which produces a deceptive appearance of very short, truncate polyps with their mouths directed outwards from the stem.

There is a considerable variety in the spicules (Pl. lxvii. fig. 1).

(1) There are somewhat flattened, curved spindles, produced on the convex side into a number of sharp, prominent teeth. The following measurements were taken of length and breadth in millimetres.— $238 \times .102$ ;  $187 \times .085$ ;  $118 \times .068$ ;  $102 \times .051$ .

(2) Spicules of similar form to (1), but simpler and with only a few small warts.— $153 \times .051$ ;  $136 \times .053$ ;  $102 \times .034$  mm.

(3) Small "Blattkeulen" with a very small shaft, bearing sometimes a few warts, and supporting a group of sharp, blade-like projections.— $102 \times .085$ ;  $99 \times .068$ ;  $51 \times .032$  mm.

(4) Small irregular bodies and "capstans."— $85 \times .085$ ;  $102 \times .085$ ;  $68 \times .051$  mm.

The colour of the colonies is pale-brown to cream.

Previously recorded from the Indian Ocean, and Port Jackson, New South Wales, 35 fathoms.

#### MOPSEA ENCRINULA, Lamarck.

*Mopsea encrinula*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, pp. 43-44, pl. vii., figs 1, 1<sup>a</sup>, 1<sup>b</sup>, pl. ix., fig 11.

Stations 34, 44, 47.

A few incomplete specimens in the present collection agree closely with the description of *Mopsea encrinula* (Lamarck), given by Wright and Studer. Branching is plume-like in one plane; the club-shaped polyps, 1 mm. long, cover the branches and twigs in a close spiral, and are incurved towards the stem. Many of the spicules are yellow and white flattened spindles, approaching the "lancet-shaped plates" of Wright and Studer's description.

These bear numerous high, projecting warts, which tend to be more numerous towards one side of the spicule than the other, especially if the spicule is curved, when the convex side is always much the stronger toothed; length by breadth in mm.  $\cdot 187 \times \cdot 051$ ;  $\cdot 15 \times \cdot 06$ ;  $\cdot 12 \times \cdot 05$ . There are also scales with very irregular margins and numerous spiny warts.— $\cdot 102 \times \cdot 082$  mm.;  $\cdot 063 \times \cdot 04$  mm.;  $\cdot 02 \times \cdot 02$  mm. Thirdly, there are small irregular bodies.— $\cdot 025 \times \cdot 025$ ;  $\cdot 051 \times \cdot 025$ .

The colour of the specimens is orange-brown; the polyps yellowish-white.

*Locality*.—Eleven miles east of Broken Bay.

Previously recorded from Australia (North-west Coast), 59 fathoms; Station 162, off East Moncoeur Island, Bass Strait, 38 fathoms.

#### MOPSEA AUSTRALIS, *sp. nov.*

(Plate lxiv. figs. 1 and 2., pl. lxvii. fig. 5.)

One specimen has the basal portion almost intact, the others are broken, branching pieces of various lengths. All are in the dried condition. The mode of branching, and, in fact, the whole general appearance of the colony is very similar to *Mopsea dichotoma* (Linné).

The polyps are arranged in close spirals round the branches. They are small ( $\cdot 5$ – $\cdot 75$  mm. in length), club-shaped, and, in the dry state at any rate, are very closely pressed to the surface of the branch, so that their mouths are hidden. Their armature consists of indistinct longitudinal rows of transversely arranged, slightly overlapping spicules; there are from fifteen to eighteen of these in the abaxial rows.

The spicules of this species are smaller than those of *M. dichotoma*, and much less spiny. The following types occur—(1) rather broad, flattened, almost scale-like spicules with relatively prominent teeth round their edges, and with a few warts over the surface. These spicules vary in shape from flattened spindles to rough  $\alpha$ -shapes and ovals. The following measurements were taken of length and breadth in millimetres.— $\cdot 187 \times \cdot 034$ ;  $\cdot 153 \times \cdot 063$ ;  $\cdot 119 \times \cdot 051$ ;  $\cdot 102 \times \cdot 068$ . (2) Stout spindles and some clubs with prominent warts.— $\cdot 153 \times \cdot 034$  mm.;  $\cdot 119 \times \cdot 017$  mm.;  $\cdot 102 \times \cdot 017$  mm. (3) Capstans and small, irregular bodies.— $\cdot 051 \times \cdot 034$  mm.;  $\cdot 034 \times \cdot 034$  mm.;  $\cdot 068 \times \cdot 017$  mm.;  $\cdot 034 \times \cdot 017$  mm.

The colour of the dried specimens is deep cream.

It must be admitted that *Mopsea dichotoma* (Linné), *M. elongata*, Roule, and the species at present under discussion, are

very closely related. The only noteworthy difference, as it seems to us, lies in the character of the spicules. Roule lays emphasis on the mode of branching, which he finds to be more sparse in *M. elongata* than in *M. dichotoma*, and with a strong tendency to the formation of long, simple branches. Our new species, *M. australis*, agrees with Roule's description of the branching of *M. elongata*, but it also agrees with the undoubted specimens of *M. dichotoma* in the present collection—so closely, indeed, that it was at first mistaken for that species. We do not think that the mode of branching can here be safely used as a specific distinction. Perhaps the same is true in regard to the details of spicule-form.

*Locality*.—Eleven miles east of Broken Bay.

MOPSEA FLABELLUM, *sp. nov.*

(Plate lxiii. figs. 1-3 ; pl. lxvii. fig. 6 ; pl. lxxi.)

Stations 34, 44.

This species is based on one complete colony and a number of pieces.

The complete specimen rises from a slightly encrusting calcareous base to a height of 24·5 cm. Branching begins at a height of 5·5 cm. and is very luxuriant ; the branches are confined almost exclusively to one plane, and there is a strong tendency to dichotomy ; they are slender throughout, and do not taper much ; the stouter branches have a diameter 2·5 mm., and the twigs of almost 2 mm., near their tips.

Near the base the diameter of the axis is 4 mm. Here the cœnenchyma has been worn off, and the bulk of the stem is made up of the horny joints which are about 2 mm. long, the calcareous joints being reduced to ·75 mm. ; in some cases they are quite overlapped by the horny joints. Higher up the calcareous joints have lengths of 3·4 mm., and the horny joints ·25-·5 mm. The colour of the horny joints is brown ; that of the calcareous joints varies from cream-white near the base of the colony to orange in the twigs. The calcareous joints bear marked longitudinal flutings. The branches arise from the calcareous joints.

The polyps occur in close-wound spirals all over the stem and branches. In the youngest twigs the spiral is wider but nowhere is there any trace of a bilateral arrangement. The polyps are club-shaped, with somewhat truncate mouths which are pressed against the cortex of the branch. The average length of a polyp is 1 mm. The calyces are armoured with about eight rather indefinite longitudinal rows of overlapping spicules,

fifteen to eighteen in a row. These spicules are flat, yellow scales circular, 8-shaped and irregular; they are smooth, or bear a few simple warts, and their margins are deeply dentate or serrate. Their dimensions in millimetres are,  $\cdot 255 \times \cdot 136$ ;  $\cdot 204 \times \cdot 102$ ;  $\cdot 17 \times \cdot 068$ ;  $\cdot 153 \times \cdot 153$ . A low eight-rayed operculum is formed by similar scales.

The spicules of the coenenchyma are yellow spindles and cylinders ( $\cdot 187 \times \cdot 035$ ;  $\cdot 17 \times \cdot 017$ ;  $\cdot 136 \times \cdot 051$  mm.). They have relatively few, but large warts. There are also small irregular bodies ( $\cdot 085 \times \cdot 051$ ;  $\cdot 051 \times \cdot 034$ ;  $\cdot 068 \times \cdot 05$  mm.).

The general colour of the colony is orange-brown, the polyps are rather lighter.

#### MOPSEA ELEGANS, *sp. nov.*

(Plate lxiv. figs. 3 and 4; pl. lxviii. fig. 5; pl. lxxii.)

Stations 34, 41, 42, 47, 48.

Several beautiful golden brown colonies, with rich dichotomous, almost parallel, branching. The largest is 34 cm. in height, with a spread of about 5 cm.; the branches have an average diameter of 2 mm. The axis shows the usual white calcareous internodes with fine longitudinal fluting and short amber-coloured nodes.

There is some variety in the origin of the branches. In certain cases the dichotomy is precisely at the node; in other cases the calcareous internode forms immediately below the node a slight shelf from which a new branch arises with a horny node as the first joint. The coenenchyma is very thin, and, with the exception of a median line on each surface, is in great part hidden by the numerous polyps. These occur in alternating rows on each side, here and there encroaching on the free median spaces. Most of the branches show two rows on each side in their upper reaches, but in the lower parts of the colony three or four rows are often seen. The polyps are somewhat club-shaped, 0.75-1 mm. in height by about 0.5 mm. in maximum breadth. They project at an acute angle to the axis, but the upper parts are incurved. In the upper reaches there are about twenty on each side in a centimetre.

The superficial spicules are flat, often oval scales, with the following dimensions in millimetres.— $\cdot 073 \times \cdot 066$ ;  $\cdot 052 \times \cdot 052$ ;  $\cdot 038 \times \cdot 055$ . Each scale shows a nucleus, often excentric, with fine ridges radiating from it. One margin of the scale is entire, the other bears more or less deep indentations, and the part of the scale to this side of the nucleus is studded with small warts. The whole might be compared to a ctenoid fish scale, and they overlap one another, the overlapped part being the smooth portion.



of the stem is missing. The stem has a maximum diameter of 4 mm.; the average diameter of the larger branches is 2 mm., and of the twigs, 1 mm. Another specimen, also incomplete, has a height of 16 cm., with a span of 11 cm. The lower part of the stem is overgrown by a sponge.

Polyps occur here and there on the branches, but they are mainly confined to the twigs, along each side of which they are arranged alternately in a single row. Frequently this arrangement becomes irregular, the polyps encroach on the middle line, or a double row may be formed along each side. There are about fifteen polyps to 1 cm. in each row.

The polyps are small, 5-7.5 mm. in height, club-shaped, truncate, and turned upwards towards the tip of the twig. They are covered with closely-fitting, elongated spicules arranged transversely, which either interlock by means of their dentate margins, or overlap one another; the abaxial rows are composed of about sixteen such spicules arranged in an imbricate manner. Similar spicules form a low, eight-rayed operculum. The spicules of the coenenchyma are like those of the polyps, but follow the longitudinal direction of the stalk and form a sort of pavement over its surface, adjacent spicules being closely interlocked by their teeth. The calcareous internodes of the axis bear fine longitudinal ridges, which are dentate at the upper and lower ends of the joint. The spicules are small, colourless, somewhat flattened spindles and lancet-shaped plates, frequently curved, and bearing numerous sharp, tooth-like warts, which are usually more strongly developed on one side of the spicule than the other. The following measurements were taken of length and breadth in millimetres:— $238 \times .085$ ;  $17 \times .068$ ;  $136 \times .051$ .

There are also numerous smaller spindles and forms approaching clubs:— $153 \times .025$ ;  $112 \times .035$ ;  $085 \times .034$ ;  $068 \times .017$  mm.

The colour of the colonies is pale-brown to cream-white, the axis occasionally tinged with pink.

*Locality*.—Eleven miles east of Broken Bay.

Genus *ACANTHOISIS*, *Wright and Studer*.

*ACANTHOISIS FLABELLUM*, *Wright and Studer*.

(Plate lxii., figs. 1 and 2.)

*Acanthoisis flabellum*, *Wright and Studer*, *Chall. Rep.*, Zool., xxxi., 1889, pp. 45-46, pl. viii., figs. 1, 1a., 1b., pl. ix., fig. 12.

Stations 22, 47 and 53.

Some very fine fan-shaped specimens of an orange-brown colour agree with *Wright and Studer's* description of *Acanthoisis*

*flabellum*, though there appears to be a stronger tendency to anastomosis than in the Challenger specimens. The height of the largest colony is 24 cm., with a width of 16 cm. across the expanded portion.

A small, broken piece of a colony is of a brown colour with the polyps tending to encroach on the middle line of the branch instead of being strictly bilateral in arrangement. The spicules here are colourless, and rather smaller than in the orange specimens.

Previously recorded from Port Jackson, 30-35 fathoms.

### Family PRIMNOIDÆ.

Genus STACHYODES, *Wright and Studer*.

STACHYODES STUDERI, *Versluys*.

*Stachyodes regularis*, Wright and Studer, Chall. Rep., Zool., xxxi. 1889, p. 55, pl. xi., figs. 2, 2\*; pl. xx, fig. 3.

*Stachyodes studeri*, Versluys, Die Gorgoniden der Siboga Expedition, ii. Die Primnoidæ, 1906, pp. 94-96, figs. 112-117.

Stations 15, 42, and 44.

Three incomplete specimens 11 cm., 23 cm. and 38 cm. in length respectively. On the most slender specimen the polyps occur in whorls of eight to nine; on the largest there are as many as ten to eleven in a whorl.

Previously recorded from Kermadec Islands, 600 fathoms; Celebes Sea (Siboga), 1080 and 1165-1264 M.

Genus AMPHILAPHIS, *Wright and Studer*.

AMPHILAPHIS PLUMACEA, *sp. nov.*

(Plate lxxv., fig. 3; pl. lxxviii., fig. 3; pl. lxxiv.)

Stations 22, 40, 44.

This delicate and graceful form bears a certain resemblance to an uncurled ostrich plume. Branching is approximately in one plane, and the branches and twigs show a strong tendency to sweep together in long, drooping curves. Occasionally the branches come off like the barbs along the shaft of a feather, but more generally the branching is dichotomous, or quite irregular.

Three of the four specimens are practically intact. The largest has a height of 18.5 cm. with a diameter near the base of 3 mm., the corresponding dimensions of the smallest are 8.5 cm. and 2 mm.

The cœnchyma is very thin, and allows the dark, bronze-like axis to shine through.

The polyps occur very rarely in two lateral rows; generally they are arranged in a spiral, which becomes closer in the upper part of the colony.

The polyps are 1.1–5 mm. in length. They stand out markedly from the branch at an angle of  $45^{\circ}$ – $60^{\circ}$ . They are armoured with eight close-set longitudinal rows of overlapping "ctenoid" scales; there are from eight to twelve in a row on the abaxial side, and a rather smaller number on the adaxial. The uppermost scale of each row is more strongly developed than the rest, and its upper edge is somewhat reflexed, so that it stands out from the operculum. In this way a sort of collar or circum-operculum is formed. Above this eight triangular scales form a well-defined, conical operculum.

The dimensions of the "ctenoid" scales in millimetres are .316 x .181; .255 x .272; .204 x .153. Their free edge is entire or crisply waved, around the well-marked nucleus numerous warts are grouped, and the clear border round the exposed portion of the scale bears strongly-marked radiating ridges.

The opercular scales are isosceles triangles with a strong concavity to the outer surface, and a corresponding ridge internally, which extends for about three-quarters the length of the scale. The surface is elaborately warted, and the narrow clear margin bears ridges. The following measurements were taken of length and breadth in millimetres.—.415 x .204; .34 x .221.

The spicules of the cœnchyma are approximately circular scales, with a central nucleus, round which warts are grouped. The border is clear, with at most a few low ridges (.187 x .17 mm.; .136 x .119 m.m.; .112 x .112 mm.).

The colour of the specimens is fawn to brown.

This species differs from *Amphilaphis regularis*, Wright and Studer, in the following points:—(1) its much more slender build, and bushier, more luxuriant branching; (2) the almost invariable arrangement of the polyps in spirals, and their much denser crowding; (3) the smaller size of the polyps, and (4) the greater number of scales in the abaxial rows of the calyx.

From *Amphilaphis abietina*, Studer, it is distinguished:—(1) by the close spiral arrangement of the polyps; and (2) by showing no tendency for the branches to come off at right angles from the stem.

*Locality*.—Eleven miles E. by N. of Barrenjoey, 30–40 fathoms.



are smaller than those described for *P. penna*, and are smoother and of more simple outline. The chief point of difference, however, lies in the mode of branching, which in *P. penna* is close and typically feather-like. Versluys speaks of as many as twenty-three twigs on each side of a branch in a stretch of 5 cm.; these twigs, moreover, are never longer than 3 cm. and are always unbranched.

*Locality*.—Eleven miles east of Broken Bay.

PLUMARELLA THEFIS, *sp. nov.*

(Plate lxvi, fig. 5; pl. lxviii, fig. 6; pl. lxxvi)

Stations 34, 40, 42, 47, 48, 53.

This handsome new species is well represented by dried specimens; two small pieces are preserved in spirit.

The colonies are typically feather-like. The long, frond-like branches bear on each side a row of alternating twigs. These twigs occasionally branch in the same pinnate manner, but usually remain simple. The polyps rarely occur on two sides of the twigs; usually they are arranged all over the twigs in close spirals. On the larger branches they may be confined to two sides, or they may be scattered indefinitely over the whole surface.

None of the specimens show the basal portion. The most richly-branched colony has a height of 32 cm., with a width of 53 cm. The stem has a diameter of 5 mm. The twigs average 3.4-5 cm. in length, with a diameter of 2 mm. There are about fourteen twigs on each side in a length of 5 cms.

Some of the colonies are much more heavily built. A single frond is 43 cm. long, with a diameter of 5.5 mm. at the base. The twigs in this case are 8-10 cm. long, with a diameter of 2-3 mm., and only seven to eight occur in each row in a length of 5 cm.

The polyps are very closely crowded over the twigs. Their average length is 1 mm. The calyx scales are arranged in longitudinal rows, of which the abaxials alone are complete. These consist of about six relatively large, overlapping scales. The adaxial rows are reduced to about one small scale, and the adaxial-laterals are also very few in number and are overlapped by the abaxial-laterals. The calyx scales are broad, shield-like and fan-like, with entire margins around the overlapping portion; the overlapped portion contains the nucleus, surrounded by numerous finely-tuberculate warts. The clear border between the outer margin and the warted portion bears radiating ridges. The following measurements were taken of the length and breadth of

the calyx scales in millimetres:— $544 \times 442$ ;  $408 \times 595$ ;  $289 \times 425$ ;  $272 \times 306$ ;  $204 \times 374$ ;  $357 \times 374$ . The eight opercular scales are of equal size— $425 \times 238$  mm.;  $391 \times 204$  mm. They are high, sharply-pointed isosceles triangles, bearing a strong median ridge; another ridge runs at right angles to the median ridge across the basal portion, so that the two together form a sort of T-square. Numerous small warts and jagged projections are grouped along the sides of the main ridges, and occur more sparsely over the "blade" of the scale; the margins of the two long sides of the scale are entire. The spicules of the coenenchyma are for the most part scales, thicker than those of the calyces, and without the clear border; they show a diversity of form, oval, fan-shaped, triangular, etc., and are closely covered with tuberculate warts which surround an excentric nucleus; their dimensions are:— $374 \times 391$  mm.;  $323 \times 153$  mm.;  $272 \times 204$  mm.;  $204 \times 17$  mm. There are also a few small approximately spherical bodies, covered with warts,  $068 \times 068$  mm.;  $085 \times 085$  mm.;  $102 \times 102$  mm.

The colour of the colonies is light brown with polyps of a lighter shade. The axis is dark brown to greenish-bronze, and is finely grooved.

This species agrees in many respects with *Plumarella spinosa*, Kükenthal. *P. spinosa*, however, has the opercular scales of very unequal size, and the scales have throughout a rather different type of ornamentation from that in our specimens.

*Locality*.—Eleven miles E. by N. of Broken Bay, 30-40 fathoms.

#### PLUMARELLA CORRUSCANS, *sp. nov.*

(Plate lxxv., fig. 4; pl. lxxviii., fig. 8; pl. lxxvii.)

Stations 40, 44, 47.

This is an extremely beautiful and graceful form with typically feather-like branching. It is well represented both among the dried specimens and among those in spirit. The largest specimen is an almost perfect colony, about 44 cm. high, with a maximum breadth across the branched portion of 26 cm. A well-developed calcareous expansion, about 2 mm. thick, attaches the colony to the substratum. From this there rises a cylindrical stem, 6 mm. in diameter, which almost from its origin gives off twigs in a single row along each side. At a height of about 19 cm. the stem divides into two main branches, which in their turn give off lesser

branches. All these ramifications bear numerous twigs which alternate in a single row along each side. There are about thirteen twigs in each row in a length of 5 cm.; the average length of a twig is 4 cm.

The polyps occur in a single row on each side of the twigs and branches—those of one row alternating with those of the other. There is great evenness and regularity in their arrangement; they never encroach on the middle line. There are about ten polyps to 1 cm. in each row; the tip of one polyp just reaches to the base of the one immediately above, the length of a polyp being 1 mm. Among the normal-sized polyps in some of the specimens there are here and there large swollen polyps of about twice the size of the others. These contain reproductive bodies.

Seen with a lens, the entire surface of the colony, both coenenchyma and polyps, presents a glistening frosted appearance that is very characteristic. The axis is almost black, and bears fine longitudinal striations.

The polyps are armed with well-defined longitudinal rows of broad, overlapping scales; there are about six of these in the abaxials, but in the lateral rows the number is considerably reduced, and the adaxials are indistinct. The operculum of eight isosceles triangles is rather high and conical in the normal-sized polyps, but much lower and flatter in the large individuals. The armature of the two kinds of polyps does not otherwise differ in any marked way, except that the scales on the bodies of the large polyps are much larger than those on the small polyps.

The polyp scales are rather thin, fan-shaped "ctenoid" forms, with a well-marked nucleus surrounded by tuberculate warts, and a relatively broad clear border round the upper half of the scale, bearing a few strongly-marked radiating ridges. The following measurements were taken of length and breadth in millimetres:— $255 \times 204$ ;  $204 \times 238$ ;  $17 \times 136$ .

The opercular scales are, as usual, isosceles triangles with a median ridge, bearing numerous small warts without definite arrangement. These scales are throughout of very uniform size— $459 \times 221$  mm. The scales of the coenenchyma are irregularly circular or oval; they are smaller than those of the polyps ( $107 \times 136$  mm.;  $102 \times 102$  mm.), and have a number of warts surrounding an approximately central nucleus.

The colour of the colonies is usually light brown; one dried specimen has a pinkish colour, which is apparently soluble, for a piece put in alcohol stained the liquid pink after a short time.

*Locality*.—Coast between Port Jackson and Port Hacking.



ments were taken :—323 x 357 mm.; 272 x 255 mm.; 119 x 1085 mm. The colour of the majority of the colonies is red-brown; one small specimen is cream-coloured, with very opaque spicules. The axis is greenish-bronze, with fine longitudinal striations.

*Locality*.—South Coast, New South Wales.

*PLUMARELLA VERSLUYSI*, *sp. nov.*

(Plate lxvi., fig. 4; pl. lxviii., fig. 2; pl. lxxix.)

Station 53.

The largest specimen has a height of 22.5 cm. with a width of about 12 cm. across the branched portion; the basal attachment is lacking. The branching is confined to one plane, and is typically feather-like. Along each side of the stem and main branches there is a row of twigs alternating with those of the opposite side. The average length of a twig is 2 cm. with a diameter of 2 mm.; there are about fourteen twigs on each side of a branch in a length of 5 cm. The polyps are arranged bilaterally on the larger branches; on the twigs their arrangement is also lateral, but a few may encroach on the middle line. Usually they stand in a single row, but occasionally the row is doubled.

The polyps are of two sizes; the majority are very small, .75 mm. in length; here and there occur larger, more swollen polyps, 1.25 mm. in length. In the smaller polyps the armature consists of overlapping scales, of which there are about four in the abaxial longitudinal rows; the lateral rows are very indistinct, and the adaxials practically obsolete; the uppermost of each longitudinal row is larger than the rest and projects, so that a slight circumoperculum is formed. The operculum is well-defined and conical, formed of eight approximately equal isosceles triangles. The armature of the larger polyps is of the same general type as that just described; but the longitudinal rows are even less distinct, the polyp scales are rather larger and more numerous, and the operculum is low.

The polyp-scales are broad and fan-shaped, with a distinct nucleus, numerous tuberculate warts, and a clear fluted margin round the part of the scale that projects when on the polyp. The general appearance of the scales is very similar to those of *Plumarella filicoides*, but they are markedly thinner, and less heavily sculptured than in that species. The following measurements were taken of length and breadth in millimetres :—425 x 289; 306 x 306; 255 x 187. The opercular scales are similar to those of *P. filicoides*, but are less strongly ridged—34 x 204 mm.; 289 x 187 mm.

The colour of the colony is rufous-brown, the polyps rather lighter.

*Position*.—This species approaches very closely *Plumarella filicoides*. The chief points of difference from that species are—(1) its more slender build, and greater tendency to branch; (2) the bilateral arrangement of the polyps; (3) the rather larger size of the polyps; (4) the larger number of scales in the abaxial rows on the polyps; and (5) the less heavy type of spicules.

Genus PRIMNOELLA, Gray.

PRIMNOELLA AUSTRALASIÆ, Gray.

(Plate lxi., fig. 1.)

*Primnoella australasiæ*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, p. 88, pl. xviii., figs. 1, 1a, pl. xxi., fig. 15.

*Primnoella australasiæ*, Versluys, Gorgoniden der Siboga Expedition, ii. Die Primnoideæ, 1906, pp. 52-54, figs. 55-59.

Stations 31, 41, 42, 43, 44, 47, 48, 53, 54.

The three largest specimens are 135 cm., 113 cm., and 83 cm. in length. In very few cases is the cœnenchyma intact; generally it is more or less worn away, and the axis of the colony is overgrown with Palythoids, Cirripedes, and in one case by *Alcyonium* (*Erythropodium*) *reptans*, Kükenthal.

*Localities*.—Eleven miles east of Broken Bay; Cape Hawke, 25-28 fathoms.

Previously recorded from Australian Seas; New Zealand; Bluff Harbour, Tasmania, 7 fathoms; Port Jackson (New South Wales), 150 fathoms; Station 163A, off Twofold Bay (New South Wales), 150 fathoms.

PRIMNOELLA FLAGELLUM, Studer.

*Primnoella flagellum*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, p. 85, pl. xviii., figs. 2, 2a, pl. xxi., fig. 12.

Station 48.

A single specimen, 155 cm. in length, without a basal attachment. The lower part of the wire-like axis is worn bare of cœnenchyma; above this, 20 cms. of the length is encrusted with Cirripedes and *Alcyonium* (*Erythropodium*) *reptans*, Kükenthal. The remainder of the colony is a long, flexible, whip-like, unbranched stem, closely covered with polyps arranged in whorls, and having an almost uniform diameter of 2 mm. There are about eight polyps in a whorl; the average length of a polyp is 1.5 mm. The geographical distribution is remarkable.

Previously recorded from—Station 308, off Tom Bay, Patagonia, 175 fathoms; S. Atlantic, near S. American coast, Lat.  $43^{\circ} 56' 2''$  S., Long.  $60^{\circ} 25' 2''$  W., 60 fathoms.

PRIMNOELLA DISTANS, Studer.

*Primnoella distans*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, pp. 85, 86, pl. xviii., figs. 1, 1a.

Stations 34, 42.

There are a number of broken pieces of this delicate form, some with the peculiar stolon-like basal attachments. The largest specimen is 15.5 cm. long. The polyps are for the most part in opposite pairs, but whorls of three occur. There are usually only five transverse rows of scales in the abaxial rows on the polyp-calyx—never so many as seven to eight, as described by Wright and Studer.

Previously recorded from—Station 23, off Sombrero, West Indies, 450 fathoms; Station 122 A-C, off Pernambuco, 120-400 fathoms; Lat.  $22^{\circ} 21'$  S., Long.  $154^{\circ} 7' 7''$  E., 550 fathoms.

Genus CALIGORGIA, Gray (emend. Studer).

CALIGORGIA LAEVIS, *sp. nov.*

(Plate lxxv., fig. 1; pl. lxxviii., fig. 7; pl. lxxx.)

Stations 47, 48.

Several incomplete branching specimens, the largest with a height of 20 cm. In two cases the stem is partially overgrown by a sponge. Branching is luxuriant and typically dichotomous; the angle of the dichotomy is small. The diameter of the thickest branches is 2.5 mm. The axis is brown.

The polyps are arranged in close whorls on the thicker branches as well as on the slender twigs. The average number of polyps in a whorl is four, but six sometimes occur, especially where a dichotomy is about to be formed, and eight is a common number on the thicker branches. The usual number of whorls in a length of 3 cm. is twenty-two to twenty-four; the length of a polyp is about 1 mm. The mouths are directed distally.

The only complete longitudinal rows of calyx scales are the abaxial and the abaxial-lateral; there are never more than nine overlapping scales in the abaxial rows; the number in the abaxial lateral is more variable, but is usually about six. The adaxial and adaxial-lateral rows are very incomplete, usually consisting of two to three scales. The opercular scales are triangular and pointed, the two abaxials being slightly larger than the others.



*Family* GORGONELLIDÆ.Genus CTENOCELLA<sup>10</sup>, Valenciennes.

CTENOCELLA PECTINATA, Pallas.

(Plate lxxxi.)

*Ctenocella pectinata*, Pallas, Elenchus Zoophytorum, 1766, p. 179.*Ctenocella pectinata*, Ridley, Zool. Coll. H.M.S. "Alert," 1884, p. 348.*Ctenocella pectinata*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, p. lxvi.

Stations 34, 42, 44, 47.

There are several very perfect colonies of typical lyre-shape; they are all in the dried condition. The height of the largest specimen is 50 cm., with a width of 42 cm. From a slightly encrusting base rises a cylindrical stem, 7 mm. in diameter, which soon forks. The two branches thus formed diverge at an angle of 45°, and give off, along the upper side only, a series of parallel, ascending twigs. The space between two twigs is about 8 mm. One or two of these lesser branches may be stronger than the rest, and may give off numerous ascending twigs in turn, or fork dichotomously. More generally, the branches are simple, from 4-12 cm. in length, and with an almost uniform diameter of 2-3 mm.

The axis is light brown, and strongly furrowed. The cenenchyma is thin, but very compact and smooth; in many places a distinct median furrow can be made out.

The polyps have, on the twigs, an irregular bilateral arrangement, but on the larger branches they occur all over the surface. They are very numerous, about 0.5 mm. apart, and are all retracted into very low, wart-like verrucæ.

The spicules include the following types:—colourless double clubs—0.68 x 0.34 mm.; 0.51 x 0.34 mm.; a few crosses—0.51 x 0.51 mm.; 0.34 x 0.34 mm.; and more elongated forms approaching double-spindles, with scarcely any "waist"—0.85 x 0.25 mm.; 0.63 x 0.25 mm.

The colour of the specimens is cream-white to yellowish.

*Locality*.—Eleven miles east of Broken Bay.

Previously recorded from Indian Ocean, seas of the Moluccas, India and China, Cuba, Australia (Warrior Reefs, Torres Strait, 12 fathoms; off N. W. Cape, W. Australia, 3-4 fathoms).

<sup>10</sup> In his "Revision of the Gorgonellidæ" (Proc. Roy. Irish Academy, 1910, p. 319), Mr. J. J. Simpson has shown convincingly that the genus *Ctenocella* should be merged in *Scirpearia*.

Order V. STELECHOTOKEA, *Bourne*.*Family* TELESTIDÆ.Genus TELESTO, *Lamouroux*.TELESTO TRICHOSTEMMA, *Dana*.*Telesto trichostemma*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, pp. 264, 265.

Station 44.

Three branching specimens, much overgrown with Hydroids, etc. The largest specimen is 19.5 cm. in height, with an average diameter of 2.5 mm. The polyps are about 5 mm. apart; they are 2.5-3 mm. in height, and project at an angle of 45° to 60°. The spicules are as described by Wright and Studer, *i.e.*, "elongated spindles with strong lateral spines, often provided with lateral branched processes, or forked at one extremity." The colour of the specimens is yellowish-brown.

Previously recorded from Torres Strait, 3-11 fathoms; Fiji Islands; Maldives.

TELESTO ARBOREA, *Wright and Studer*.

(Plate lxvii., fig. 2.)

*Telesto arborea*, Wright and Studer, Chall. Rep., Zool., xxxi., 1889, pp. 262-264, pl. xxxix., figs. 1, 1a.*Telesto arborea*, Thomson and Henderson, Proc. Zool. Soc., 1906, pp. 434-435.

Station 42.

There are a few small, much broken species in the present collection. The lateral polyps have dimensions of 4 x 2 mm. or 5 x 2.5 mm. The colour is dark brown. The spicules are as described by Wright and Studer; we give a figure of them here, as there is apparently none in any previous report of this species.

Previously recorded from Arafura Sea, 49 fathoms; Zanzibar (Kokotoni Harbour, 5 fathoms, and Wasin Channel, 10 fathoms); Maldives.

*Family* KOPHOBELEMNONIDÆ.Genus KOPHOBELEMNON, *Kölliker*.KOPHOBELEMNON SCHMELTZII (*Kölliker*).

*Sclerobelemnon schmeltzii*, *Kölliker*, *Anatom. Systemat. Beschreib. Alcyonarien*, 1 Abth. Die Pennatuliden, 1872, p. 312, pl. xxi., figs. 184A, 184B, 185.

Station 25.

Three specimens of a chocolate-brown *Kophobelemnon*. The colonies are cylindrical, 13-14 cm. high, the polyp-bearing portion rather thicker (7-9 mm.) than the stalk (5-6 mm.); there is no terminal bladder; the polyps are arranged in rather irregular longitudinal rows, leaving only a small bare strip on the pro-rachidial side. The tentacles of the polyps are without spicules. The upper part of the polyps is much poorer in spicules than the lower. Siphonozooids, small, brown, wart-like, in very numerous longitudinal rows. Axis thick, with a tendency to quadrangular cross-section in the lower part of the colony. Spicules biscuit-shaped, flat discs and  $\alpha$ -shapes, with a few warts. They are very sparse in the cutis of the stalk, numerous in the club portion round the siphonozooids and on the polyps, absent in the interior.

This description agrees with that of *Sclerobelemnon schmeltzii*, *Kölliker*.

Thomson and Simpson have shown<sup>11</sup> that it is impossible to maintain a hard and fast line between the genera *Kophobelemnon* and *Sclerobelemmon*, since there exist species such as *Kophobelemnon bürgeri*, Herklots, and *K. intermedium*, Thomson and Simpson, partaking of the characters of both. We therefore keep this species in the older genus *Kophobelemnon*.

*Locality*.—Off Newcastle, 24-48 fathoms.

Previously recorded from Formosa.

*Family* PTEROEIDIDÆ.Genus GODEFFROYIA, *Kölliker*.GODEFFROYIA ELEGANS, *Kölliker*.

*Godeffroyia elegans*, *Kölliker*, *Anatom. Systemat. Beschreib. Alcyonarien*, 1 Abth. Die Pennatuliden, 1872, p. 116, figs. 63-65.

Stations 22, 54.

*Kölliker* gives the following statement of the generic characters—"Small, delicate sea-pens, of the same type of growth as *Pter-*

<sup>11</sup> Thomson and Simpson—An account of the Alcyonarians collected by R.I.M.S.S. "Investigator" in the Indian Ocean. Part ii, 1909.

*oeides*. The siphonozoid-plate forms on the ventral border of the pinnule a cushion that extends on to the keel. Pinnules provided with one strong supporting row of needle-like spicules on the ventral border only, otherwise without strong rays of spicules. Autozoid zone abutting on the ventral spicule row, supported by numerous small needles, and having several rows of autozooids on each side."

This diagnosis was founded on a single specimen of small dimensions. Our three specimens agree with it in all essentials, but are very much larger.

The following table gives their dimensions in centimetres:—

	Sp. A.	Sp. B.	Sp. C.
Length of entire colony ...	19	18	14
„ rachis ...	10	9.5	8.5
„ stalk ...	9	8.5	5.5
Breadth of rachis ...	5.5	5	4.5
„ stalk ...	1.4	1.2	1.1
„ keel in the middle ...	1.5	0.8	0.9
Length of pinnules on ventral side...	3	2.5	2
Maximum breadth of pinnules ...	1.1	0.9	0.8
Number of pinnules on each side ...	35	27	26

The colour of all three specimens is dark brown, with a purplish tinge on the keel and pinnules.

Previously recorded from the Gulf of Siam.

Genus *SARCOPHYLLUM*, *Kölliker*.

*SARCOPHYLLUM AUSTRALE*, *Kölliker*.

(Plate lxxxii.)

*Sarcophyllum australe*, *Kölliker*, *Anatom. Systemat. Beschreib. Alcyonarien*, 1 Abth. Die Pennatuliden, 1872, p. 116, figs. 66, 67.

Stations 28, 31, 32, 54.

A number of specimens agree in the main with *Kölliker's* account of *Sarcophyllum australe*. At the intersections of the pinnules there are, on the ventral side, prominent transverse cushions bearing minute siphonozoids. The spicules in the interior of the lower part of the stem are relatively enormous, white 8-shaped forms and a few discs, at once visible to the naked eye. With regard to the other characters, we found some variation in the different specimens, variations that may well be dependent on the age and vigour of the colony. For instance, in the larger specimens there are numerous rows of autozooids on the pinnules, in accordance with *Kölliker's* account, but a small and obviously young specimen has on most pinnules only one row

of autozooids, rarely two. Hickson notes much the same thing in his Preliminary Report on a collection of Alcyonaria and Zoantharia from Port Phillip.<sup>12</sup>

Again, one of the marks that is given by Kölliker to distinguish the genus *Sarcophyllum* from *Pteroeides* is the absence of spicule-rays in the pinnules. We found this to hold true for all the larger specimens, but, in the young colony above referred to, which has much less fleshy pinnules, the rays of spicules were very well marked. This seems to us of considerable interest as indicating the danger that arises from basing genera on characters that may be present in the full-grown form only. We were in considerable difficulty in the present instance, until we detected the eminently characteristic spicules of *Sarcophyllum australe* in the base of the colony. The following table gives the dimensions in cm. of the largest, and of the smallest specimens:—

		Specimen A.	Specimen B.
Length of the entire colony	...	22.5	7.2
" rachis	...	13	3.5
" stalk	...	9.5	3.7
Breadth of the rachis	...	6.5	0.9
" stalk	...	5.5	0.3
Maximum breadth of pinnules	...	3	0.4
Height of pinnules in the middle	...	2	0.4
Number of pinnules on each side	...	30	27

In all the larger colonies the stalk is greatly swollen midway between the rachis and the base. The smallest specimen shows no such swelling.

The colour of the specimen is light brown to dark chocolate-brown, sometimes with a purplish tinge here and there.

*Localities*.—Cape Hawke, 10-12 fathoms, and 25-28 fathoms; off Port Stephen, 32-48 fathoms.

Previously recorded from Australia—Port Phillip, Victoria (Hickson).

<sup>12</sup>Hickson—Proc. Roy. Soc. Vict., n.s., ii., 1890 p. 136.





EXPLANATION OF PLATE LXI.

- Fig. 1. —*Alcyonium* (*Erythropodium*) *reptans*, Kükenthal, growing  
on axis of *Primnoella australasica*, Gray. x 5.
- Fig. 2.—Polyp of *Alcyonium etheridgei*, sp. nov. x 20.
- Fig. 3.—Lobe of colony of the same with expanded polyps. x 2.







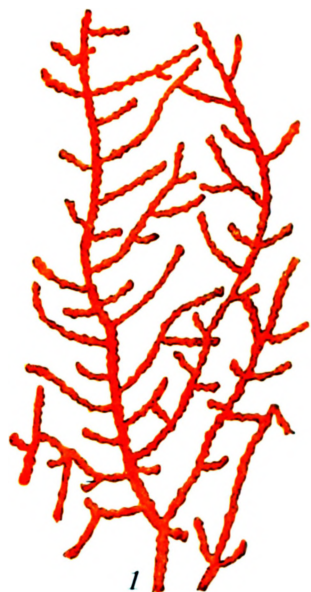
EXPLANATION OF PLATE LXII.

Fig. 1.—*Acanthoisis flabellum*, Wright and Studer. x 2.

Fig. 2.—Detail of the same. x 20.

Fig. 3.—Very young colony of *Alcyonium etheridgei*, sp. nov. x 2.

Fig. 4.—*Dendronephthya waitei*, sp. nov. Complete colony. Nat.  
size.







EXPLANATION OF PLATE LXIII.

- Fig. 1.—Small portion of colony of *Mopsea flabellum*, sp. nov.  
Nat. size.
- Fig. 2.—Axis of same. x 3.
- Fig. 3.—Enlargement of polyps. x 12.
- Fig. 4.—Spicules of *Mopsella textiformis*, Lamarck.
- Fig. 5.—Axis of same, with a few patches of cœnenchyma. Nat.  
size.







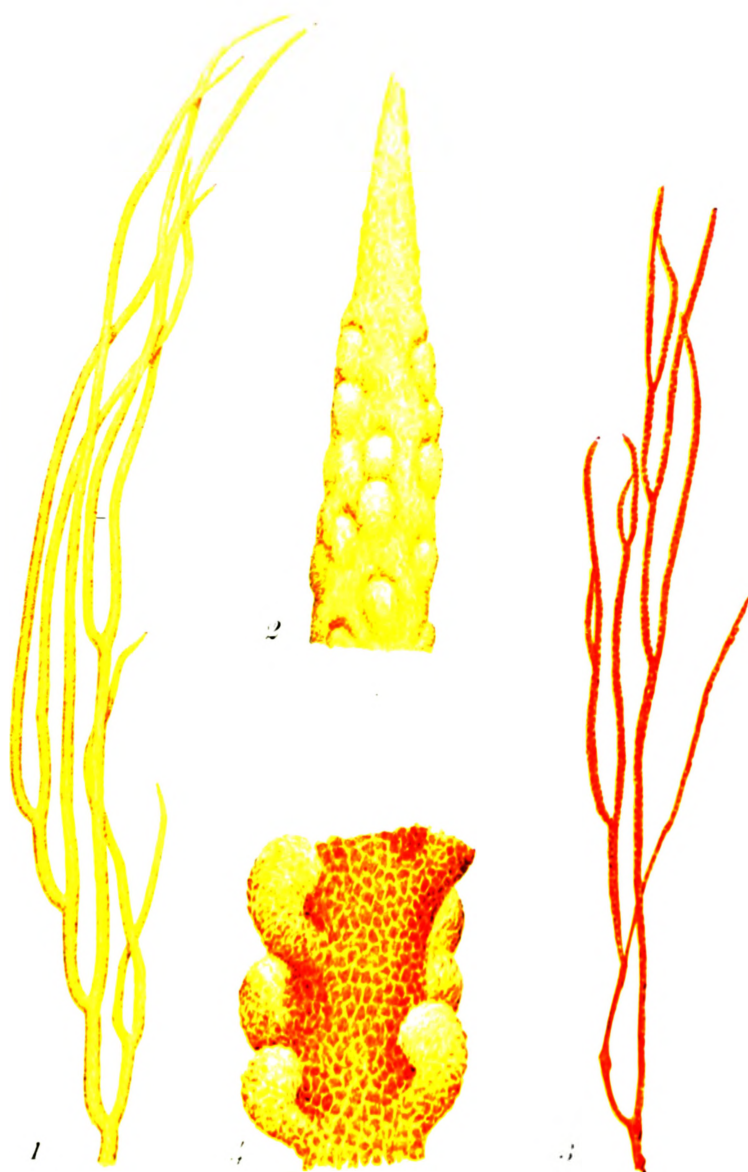
EXPLANATION OF PLATE LXIV.

Fig. 1.—*Mopsea australis*, sp. nov. Nat. size.

Fig. 2.— „ „ . Enlarged tip of a dried branch. x 15.

Fig. 3.— „ *elegans*, sp. nov. Small portion of a colony.  
Nat. size.

Fig. 4.— „ „ . Enlargement of stem and polyps. x 25.

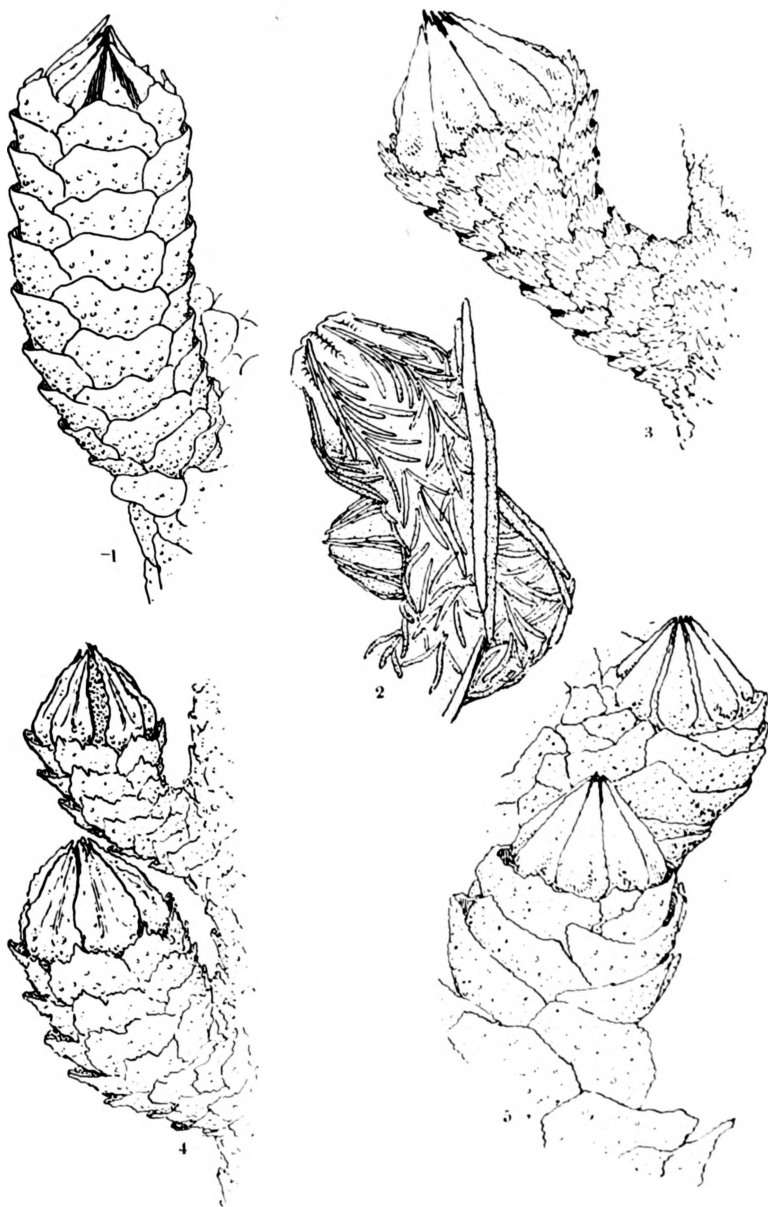






EXPLANATION OF PLATE LXV.

- Fig. 1.—Polyp of *Caligorgia lævis*, sp. nov.  
Fig. 2.— „ *Dendronephthya waitei*, sp. nov.  
Fig. 3.— „ *Amphilaphis plumacea*, sp. nov.  
Fig. 4.— „ *Plumarella corruscans*, sp. nov.  
Fig. 5.— „ *Plumarella filicoides*, sp. nov.







EXPLANATION OF PLATE LXVI.

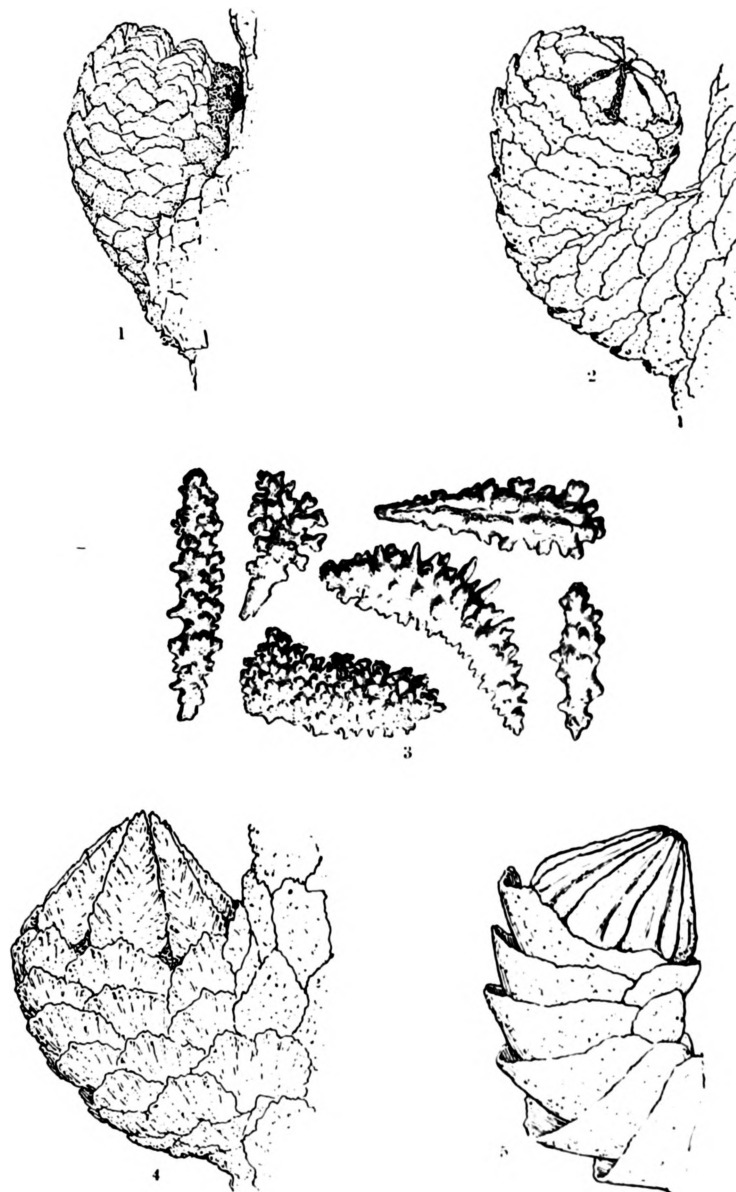
Fig. 1.—Polyp of *Plumarella lævis*, sp. nov.

Fig. 2.— „ *Mopsea whiteleggei*, sp. nov.

Fig. 3.—Spicules of the same.

Fig. 4.—Polyp of *Plumarella versluysi*, sp. nov.

Fig. 5.— „ „ *thetis*, sp. nov.

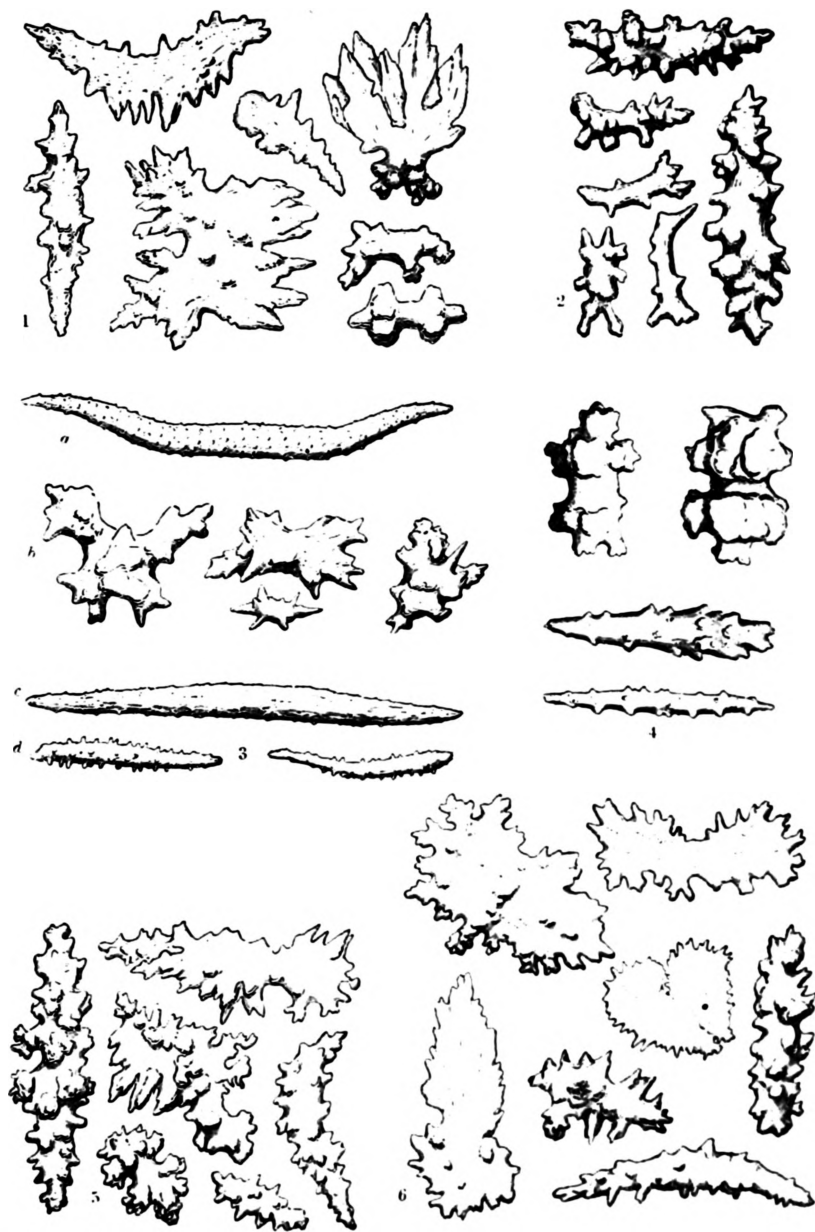






#### EXPLANATION OF PLATE LXVII.

- Fig. 1.—Spicules of *Mopsea dichotoma*, Linné.  
Fig. 2.— „ *Telesto arborea*, Wright and Studer.  
Fig. 3.— „ *Dendronephthya waitei*, sp. nov., (a) cortex ;  
(b) base, (c) Stützbündel, (d) polyp.  
Fig. 4. - „ *Alcyonium etheridgei*, sp. nov.  
Fig. 5 — „ *Mopsea australis*, sp. nov.  
Fig. 6.— „ „ *flabellum*, sp. nov.

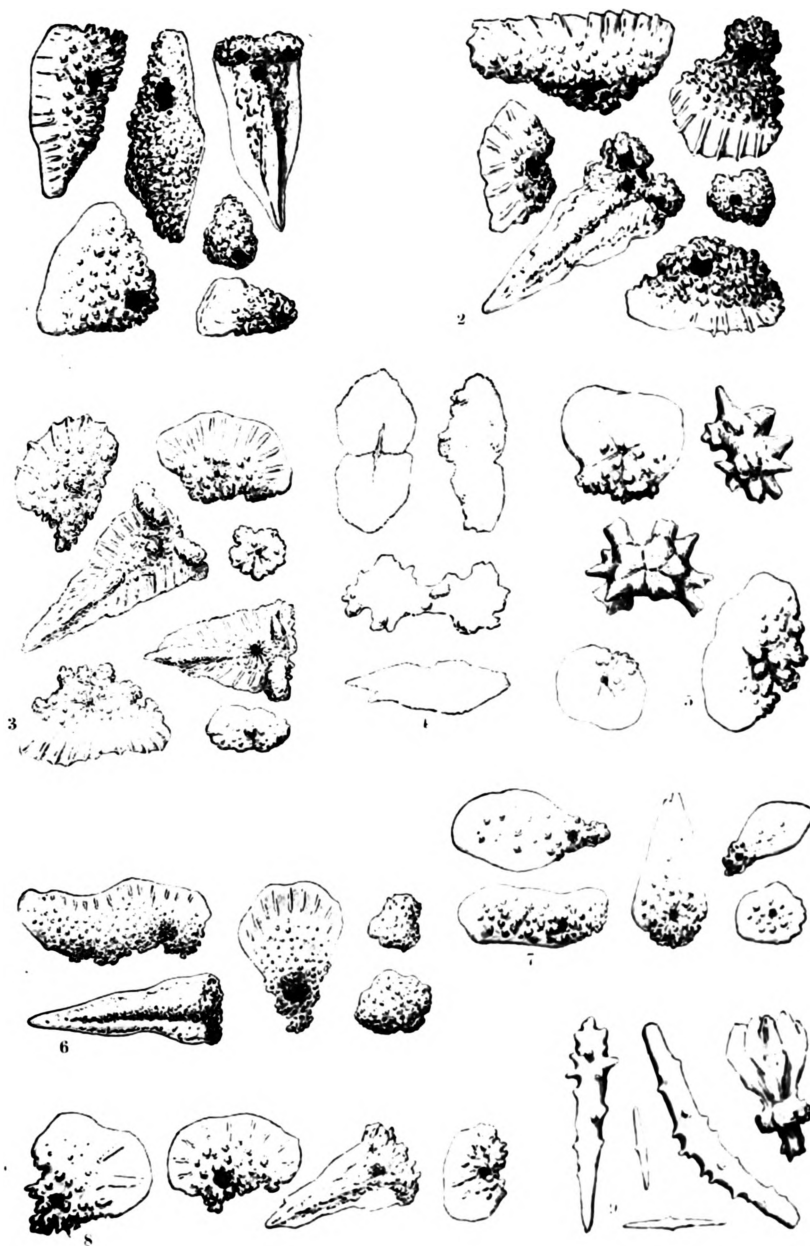






EXPLANATION OF PLATE LXVIII.

- Fig. 1.—Spicules of *Plumarella filicoides*, sp. nov.  
Fig. 2.— „ „ *versluysi*, sp. nov.  
Fig. 3.— „ *Amphilaphis plumacea*, sp. nov.  
Fig. 4.— „ *Plumarella lævis*, sp. nov.  
Fig. 5.— „ *Mopsea elegans*, sp. nov.  
Fig. 6.— „ *Plumarella thetis*, sp. nov.  
Fig. 7.— „ *Caligorgia lævis*, sp. nov.  
Fig. 8.— „ *Plumarella corruscans*, sp. nov.  
Fig. 9.— „ *Mopsella clavijera*, Ridley.







**EXPLANATION OF PLATE LXIX.**

*Alcyonium etheridgei*, sp. nov. Nat. size.

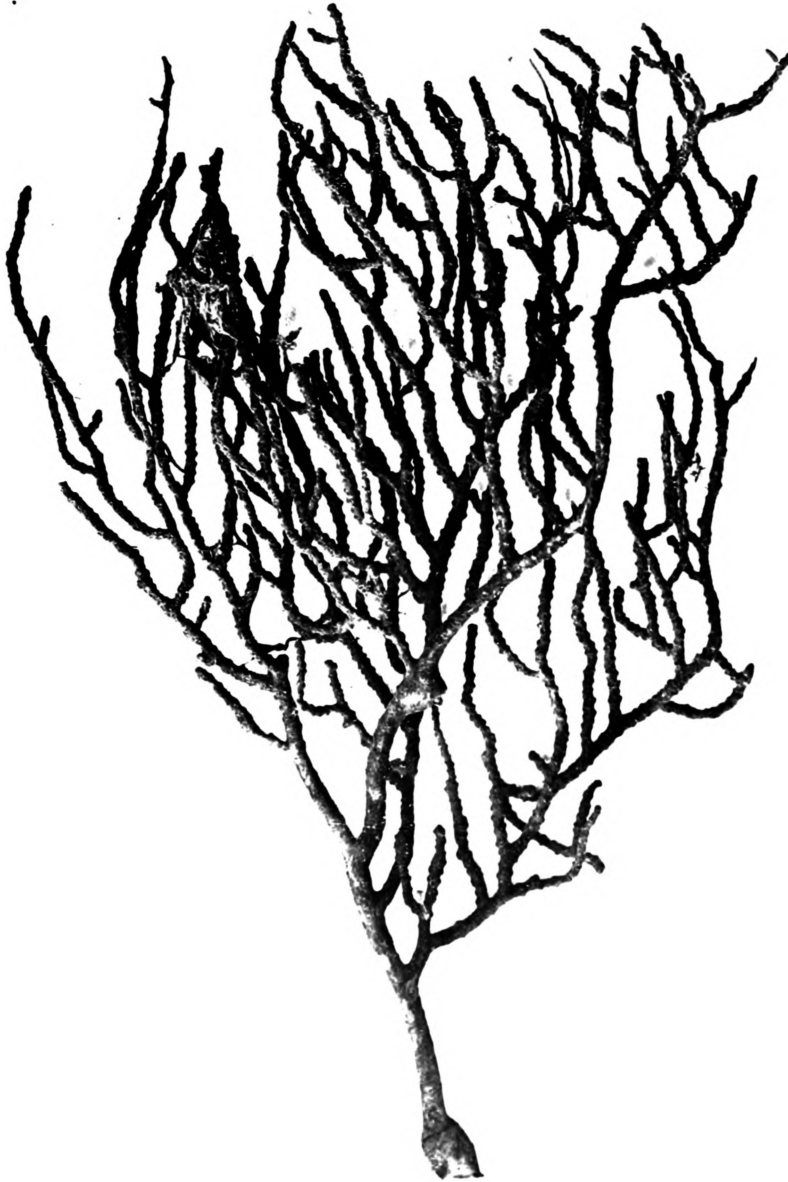






**EXPLANATION OF PLATE LXX.**

*Parisis australis*, Wright and Studer.  $\frac{3}{4}$  nat. size.







**EXPLANATION OF PLATE LXXI.**

*Mopsella flabellum*, sp. nov. Nat. size.







**EXPLANATION OF PLATE LXXII.**

*Mopsea elegans*, sp. nov. Nat. size.

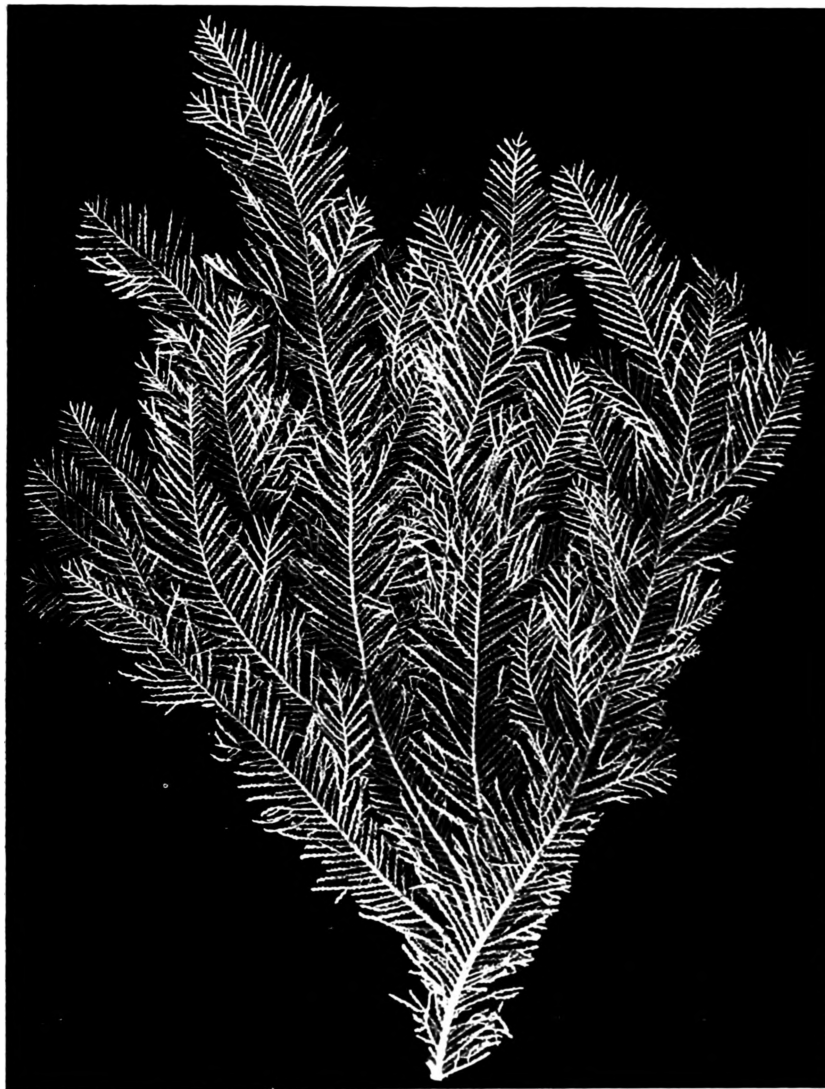






**EXPLANATION OF PLATE LXXIII.**

*Mopsea whiteleggei*, sp. nov. Nat. size

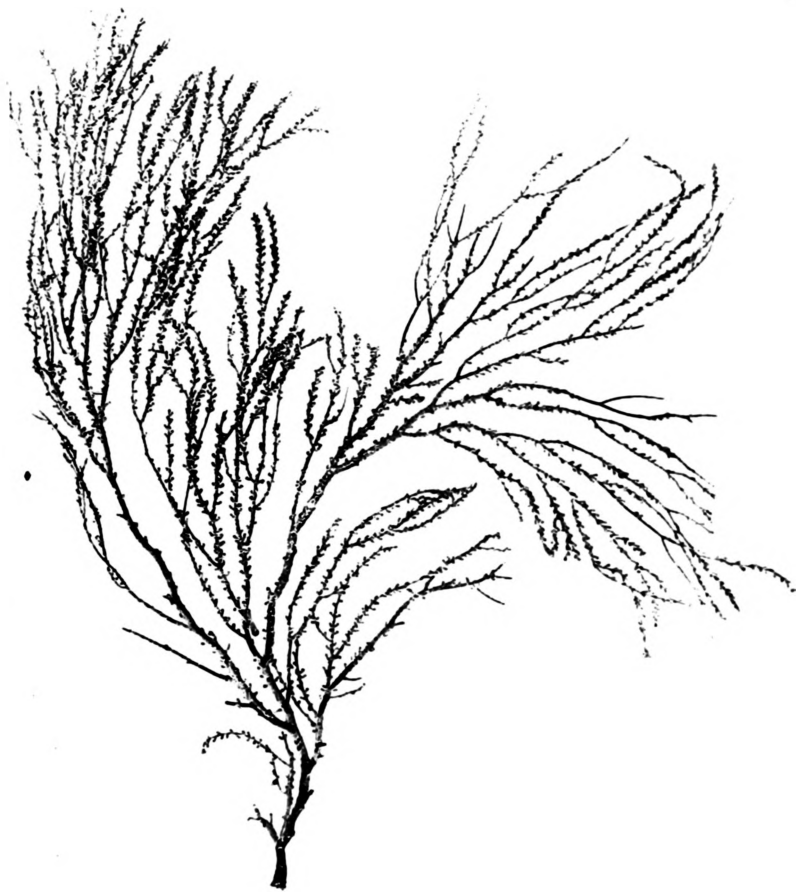






**EXPLANATION OF PLATE LXXIV.**

*Amphilaphis plumacea*, sp. nov. Nat size.

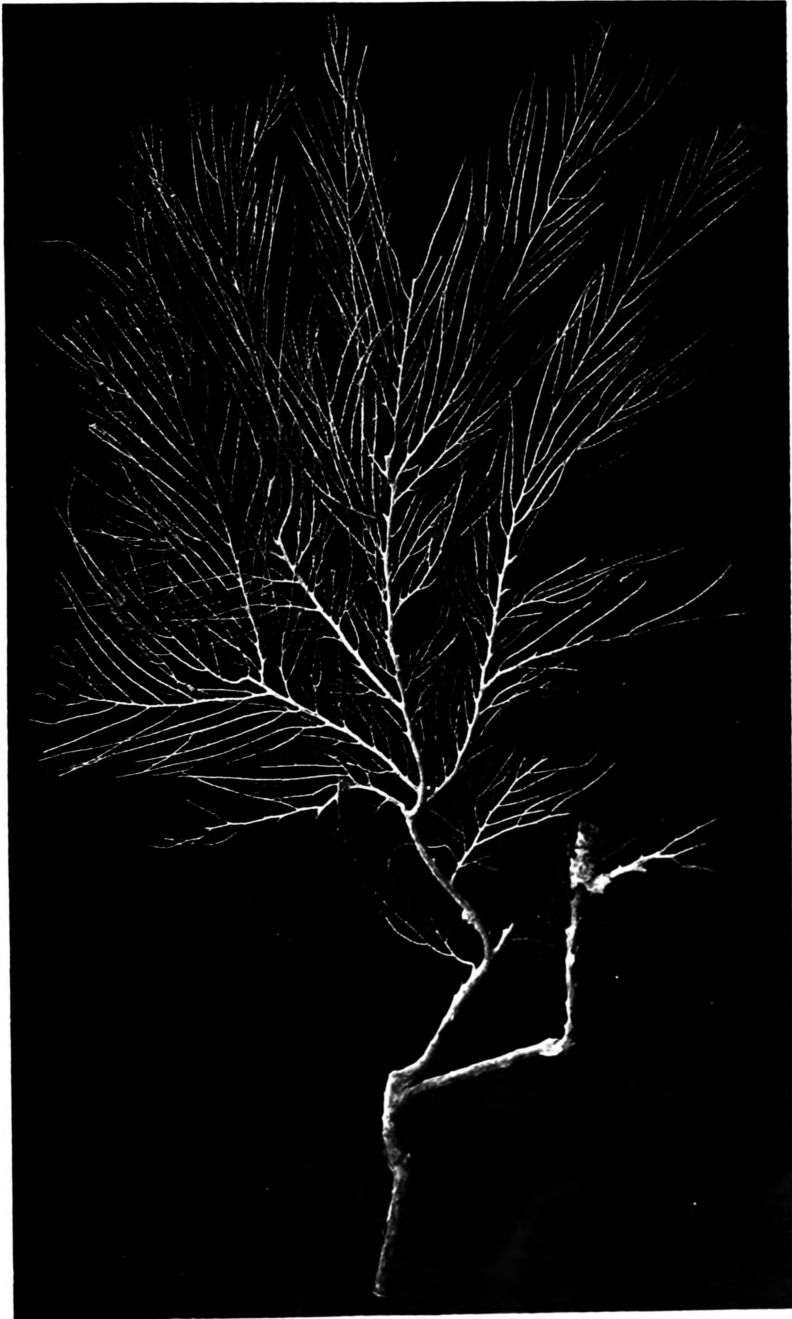






**EXPLANATION OF PLATE LXXV.**

*Plumarella laevis*, sp. nov. Half nat. size.

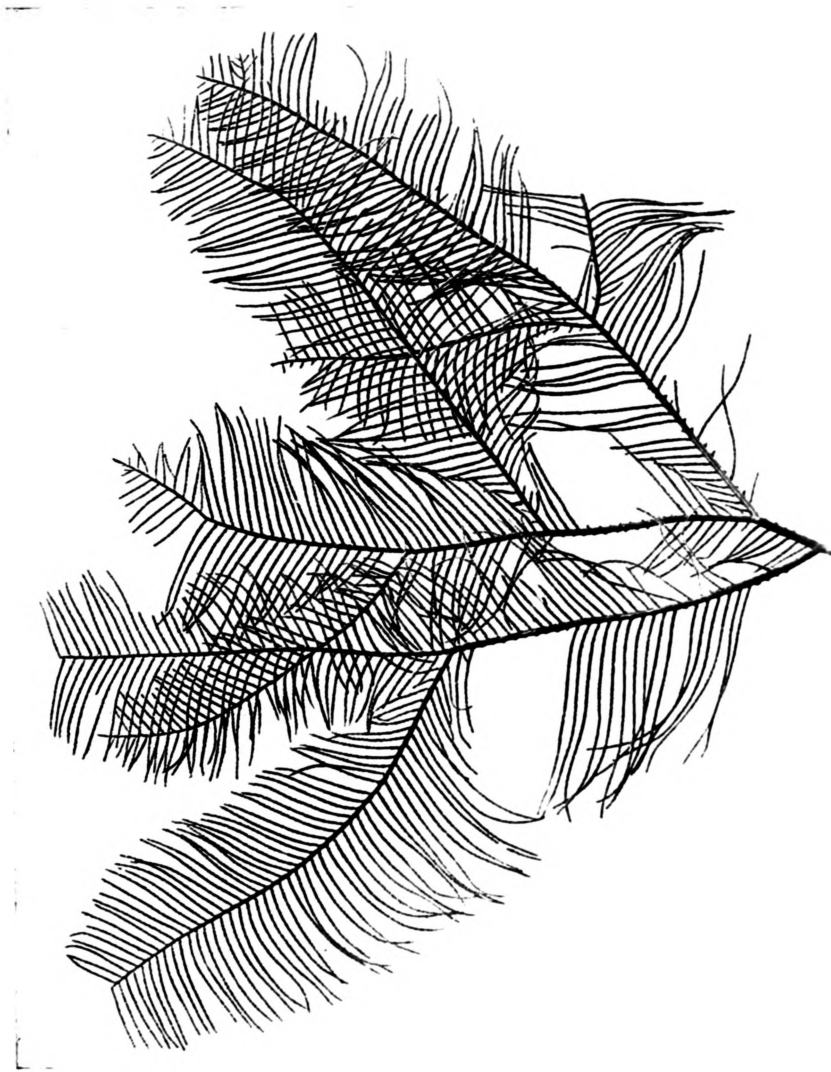






**EXPLANATION OF PLATE LXXVI.**

*Plumarella thetis*, sp. nov. Nat. size.







EXPLANATION OF PLATE LXXVII.

*Plumarella corruscans*, sp. nov. Half nat. size

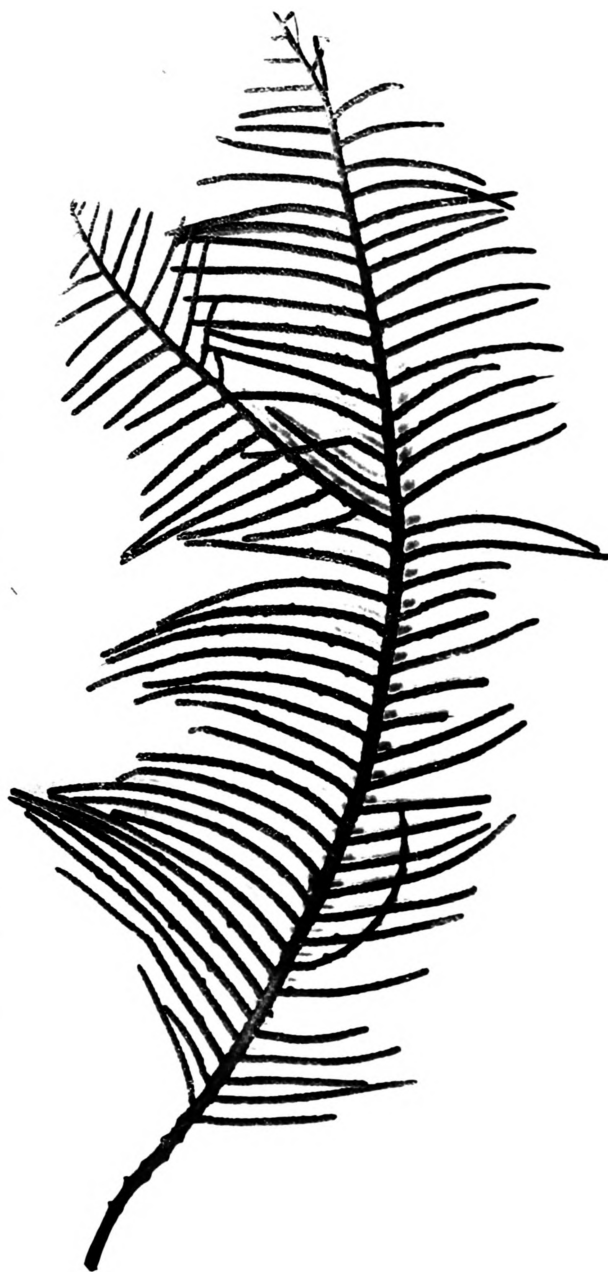






**EXPLANATION OF PLATE LXXVIII.**

*Plumarella filicoides*, sp. nov. Nat. size.







**EXPLANATION OF PLATE LXXIX**

*Plumarella versluysi*, sp nov. Nat. size.







**EXPLANATION OF PLATE LXXX.**

*Caligorgia laevis*, sp. nov. Nat. size.

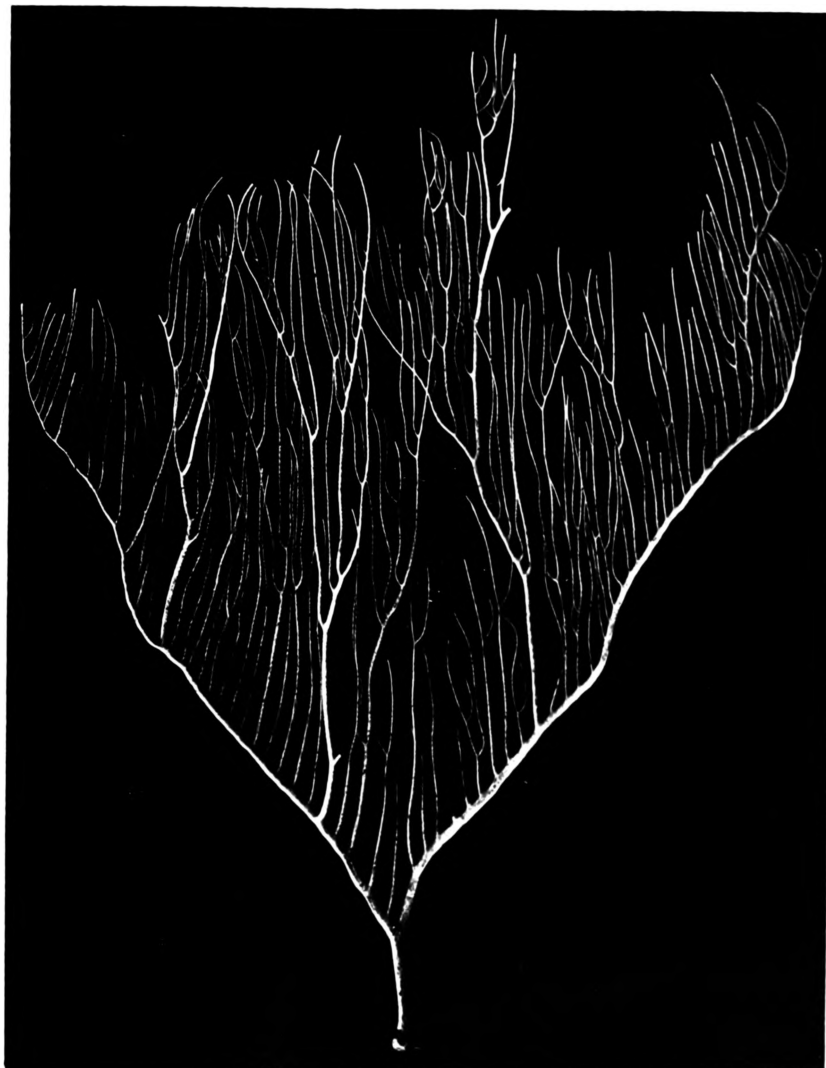






**EXPLANATION OF PLATE LXXXI.**

*Ctenocella pectinata*, Pallas. Half nat. size.







**EXPLANATION OF PLATE LXXXII.**

*Sarcophyllum australe*, K  lliker. Nat size.





